RECORDS

OF THE

SAIDÁPET EXPERIMENTAL FARM,

TO WHICH IS ADDED

A GUIDE TO THE FARM.

COMPILED AND EDITED, UNDER THE ORDERS OF GOVERNMENT,

BY

CHARLES BENSON,

MEMBER OF THE ROYAL AGRICULTURAL COLLEGE, ENGLAND,
AGRICULTURAL REPORTER TO GOVERNMENT,
AND SUPERINTENDENT, GOVERNMENT FARMS, MADRAS.

MADRAS:
ED BY E. KEYS, AT THE GOVERNMENT PRESS.

1885.

Presented, with best wishes
to M. R. Ry C Kristasami
Mudaliar Avergal, of
Shiyali, by the Acting
Director of Revenue Settle=
=ment & Agriculture

March 5th
1886.

W W Glenny
Ag Director

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PREFACE.

Six years ago in introducing the Saidápet Farm Manual to notice, I remarked that it was "prepared in order to bring together, in a form convenient for reference, the most interesting and valuable writings referring to the practice of agriculture in this Presidency, which are to be found scattered through the annual and special reports, submitted by the agricultural officers of the Madras Government during the past ten years; many of these reports being either out of print or otherwise not available to the public.

"A short guide to the Saidápet Experimental Farm has been added to the compilation, in order that the farmer and agricultural student may be able to comprehend the circumstances under which the results and experience narrated have been gained. This guide will enable any one to judge whether it is likely, under the conditions with which he himself has to deal, that similar results would be obtained if he adopted the practices detailed; he will also be assisted in deciding what modifications of them would in his case be advisable. He should, however, not forget that in farming it is impossible to reduce, to the accuracy and preciseness usual in a manufactory, the results of the operations performed. Agriculture is, more than any profession, dependent on nature for success." Since this was written new facts have been accumulated, and the book has been out of print for a considerable period.

In this compilation the same objects have been held in view. It is hoped that this collation of information scattered through a number of reports may be valued by the public. There is nothing that so much reduces the value of periodical reports as that the regular submission of them involves the publication of fragmentary results.

A good deal of illustrative information also appears in this book in addition to what has been published in reports, and in fact which could find no place in them, and I hope that the utility of the work has been increased thereby. It has now been a long time in hand, but I hope it will in consequence have the advantage of bringing to remembrance more of those facts which are so easily forgotten when they appear in periodical publications.

In conclusion, I cannot do better than again quote from the Saidápet Farm Manual:

"Agricultural experiments are in all countries surrounded by many difficulties; and only to be carried out at great cost to the experimenter; although the results obtained may be of incalculable value to the public at large. I might quote on this subject from the writings of many of

the leading authorities on scientific agriculture, but will only give the following extract from Von Thaer's 'Principles of Agriculture':—'*These experiments, it is true, are not easy; still they are in the power of every thinking husbandman. He who accomplishes but one, of however limited application, and takes care to report it faithfully, advances the science, and, consequently, the practice of agriculture, and acquires thereby a right to the gratitude of his fellows and of those who come after. To make many such is beyond the power of most individuals, and cannot be expected.*' In this country, however, agricultural experiments have been and are surrounded by many difficulties, which in other countries are almost unfelt. The almost entire absence of reliable information regarding the rational performance of the tillage of the ground, of the culture of any of our common crops, or of the management of live stock under the conditions with which we have to deal, has been a drawback to progress, which it is scarcely possible to overrate. The want of co-adjutors, working for the same object as the officers of Government, has also been a great obstacle to the collection of reliable data on which to base conclusions of a definite nature.

"On the Saidápet Farm numerous alterations, rendered necessary after it had been in operation some years by a change in its objects, together with the difficulty of obtaining that uniformity of condition in preparation for experiments, which is necessary for the collection of reliable data owing to the apathy, ignorance, and carelessness of the labourers, and to the impossibility which exists for Europeans to remain all day exposed to the sun in the plains, have retarded the progress of research greatly. At the same time the chances of success attending experimental work are always reduced by the extremes of heat and moisture, of flood and drought, which characterise the climate, and by the depredations of birds, animals, and insects, as well as from the general habits of allowing domestic animals to graze at large, and of petty pilfering from the fields.

"It should not be forgotten by the reader that this work only attempts to show the local agricultural experience gathered at Saidápet up to the present time; as this has been gained at one place only, and in a very limited period, and as, besides the farm here, there have been no similar institutions in any part of the Presidency, it is quite possible that wider and fuller experience will controvert many of the opinions which are expressed; on many points light will doubtless be thrown in the future, and many results will be negatived or confirmed by further trial."

When the Saidápet Farm Manual was published we had just passed through a terrible famine and its appearance was opportune. I hope that these records may be equally opportune in suggesting action towards the prevention of future famines.

SAIDÁPET,
MARCH 1885.

C. BENSON.

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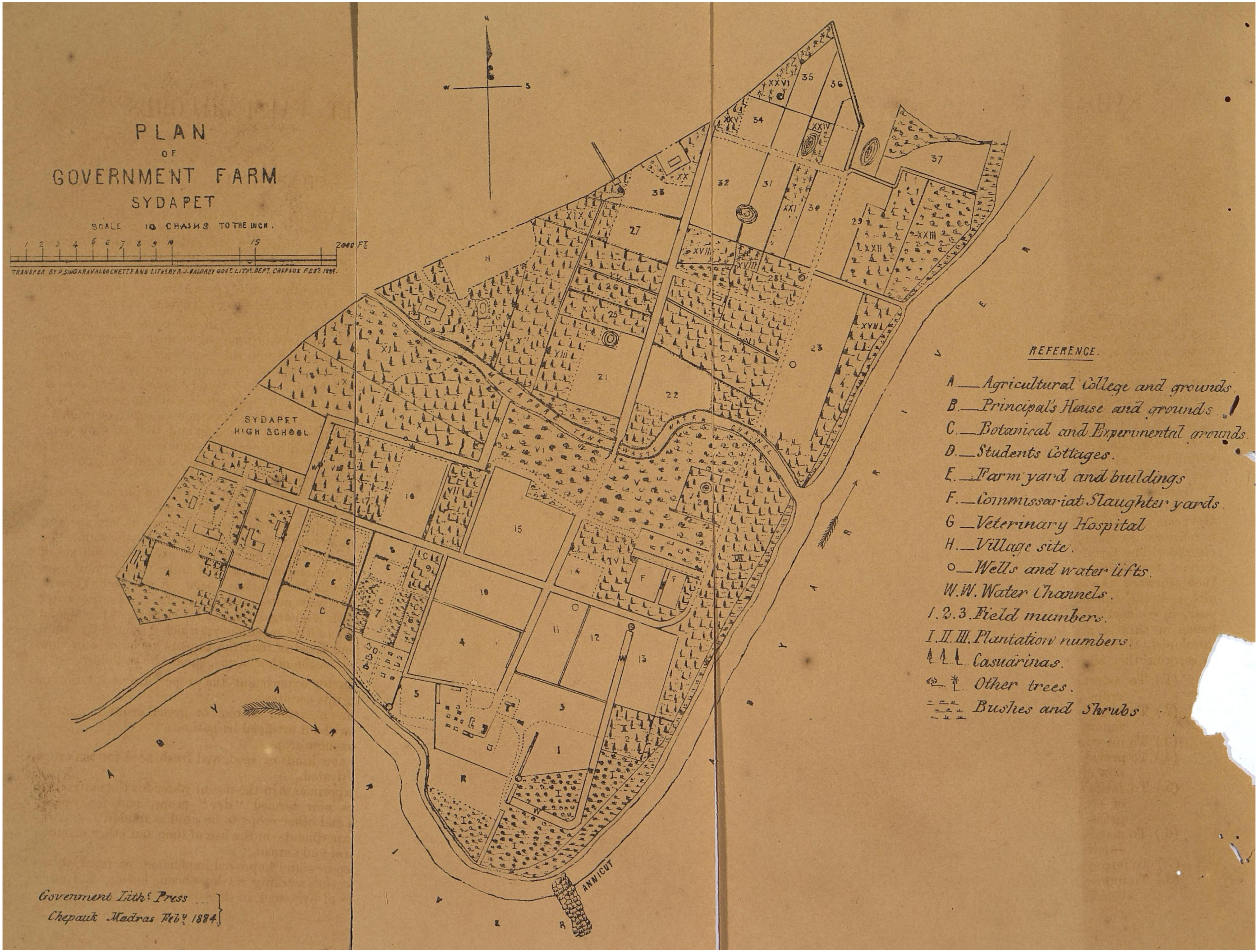
PLAN
OF
GOVERNMENT FARM
SYDAPET
SCALE 10 CHAINS TO THE INCH.
2000 FT.
TRANSFER BY P. SINGARAVALOO CHETTY AND LITH. BY R. J. BALDREY GOVT. LITH. DEPT. CHEPAUK FEBY. 1884.
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S
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MYLAPORE TANK
EAST WATER CHANNEL
ANNICUT
ADYAR RIVER
REFERENCE.
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B. Principal's House and grounds.
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1.2.3. Field numbers.
I.II.III. Plantation numbers.
Casuarinas.
Other trees.
Bushes and Shrubs.
Government Lithc. Press
Chepauk Madras Feby. 1884.

SAIDÁPET FARM RECORDS.

CHAPTER I.

GUIDE TO THE FARM.

THE farm is situated between five and six miles south of Madras, just beyond municipal limits, in the Saidápet taluk of the Chingleput district, on the northern bank of the Adyar, which forms its southern and eastern boundaries, the other sides being nearly entirely surrounded by the high-road from Madras to St. Thomas' Mount.

The HISTORY of the farm is peculiar. In the course of the year 1865, two estates, which had formerly belonged to the Nawab of the Carnatic and had recently passed into the possession of Government, were made over to a committee of gentlemen for the purpose of starting an experimental farm. Before being handed over, the land had been for many years entirely neglected and the surface was almost entirely covered with a low dense pestiferous scrub of prickly-pear and wild guavas: there were no roads, and the existing wells were in a ruinous state, choked with rubbish, and most of them dry; whilst the land was broken up with old brick-yard pits and covered with the ruins and foundations of old buildings.

The land was selected, or rather taken up, for the purpose simply because it was the only available piece of land in the hands of Government at the time, whilst it was desirable, from its having been a nuisance to the neighbouring town of Saidápet, that it should be cleared. The farm was managed by the committee with the aid of various temporary superintendents till November 1868, and from thenceforward the direction of it has been in the same hands, although the committee was not dissolved till 1871. In the latter year, in connection with a general scheme for starting experimental farms in various parts of the presidency, which has not yet been developed, Government decided that the objects to be held in view in working this, as well as the other farms, should be as follow :—

(1.) To ascertain by experiment the proper use of rotation in crops in this country.

(2.) To introduce a system of root or green crops in lieu of fallow, without artificial irrigation.

(3.) To introduce new crops.

(4.) To provide new kinds of seed, and fresh seed for the crops now cultivated.

(5.) To make experiments in the use of water for the cultivation of crops now termed "dry" crops, and for raising grasses and other crops to be used as fodder.

(6.) To make experiments in the use of lime and other manures —mineral and animal.

(7.) To introduce new and improved implements of rural labour.

(8.) To improve the working cattle, sheep, horses, and other varieties of live-stock in the country.

Since then no definite change in its objects has been made, although, since the establishment of the Agricultural College in 1876, it has been necessary to carry on alongside genuine experimental work a certain amount of ordinary farming operations for the benefit of the students. In experimental work, the objects of the farm probably need revision, and the altered circumstances and progress made since 1871 should allow of some commencement being made ere long in experimental research of scientific value to India and the World.

GEOLOGY.—Mr. Foote remarks regarding the geology of the neighbourhood:—

"The following tabular statement illustrates the various groups into which the rocks of the Madras area have been classified :—

"Recent or quaternary ...	Blown sands. Alluvium, marine and fluviatile. Laterite and Conjeeveram gravels.
"Tertiary	Gritty sandstones. Cuddalore sandstones.
"Secondary	(Cretaceous ?) Jurassic, Rajmahal plant beds.
"Sub-metamorphic ...	Cuddapah group.
"Metamorphic	Gneissic series."

"The formations chiefly prevalent are :—

"1st. *The Blown Sands.*—These sub-aerial deposits are of no great extent or importance. The greatest width obtained by this coast ridge may be about a mile.

"2nd. *The Alluvial Formations.*—These are of two classes, marine (including estuarine) and fluviatile, but they are nearly undistinguishable in character, and at many points graduate into each other imperceptibly. Their general character, as seen at the surface, is that of pure, or nearly pure, silicious sands; but beds of black, blue or grey clay occur largely below the surface in the marine alluvium near Madras; these are, however, much less frequent in the fluviatile alluvium higher up the river valleys. The river alluvia are of more interest than the marine, because they afford evidence of some remarkable changes within the human period in the courses of several of the principal rivers in the district.

"3rd. *Lateritic Formations.*—The formations classed under the above heading are of three principal kinds, namely, clayey conglomerates, gravels and sand which occur distributed over nearly the whole of the area under consideration. These formations are found constantly graduating into each other in such a manner that they can only be regarded as parts of one and the same deposit, however various the appearance of the different members. In the Madras area and to the north of Madras in the Nellore district, the character of the lateritic formations is considerably different from that of the representatives of the same series further south in Trichinopoly and South Arcot districts, the difference consisting in the much greater frequency of conglomerates and in the presence of large quantities of quartzite pebbles enclosed in the conglomerates. The laterite gravels frequently contain pebbles of quartzite and gneiss mixed with the pisiform ferruginous pellets in varying proportion according to their proximity

or distance from the older quartzite-yielding rocks. The sands associated with the lateritic conglomerates and gravels show considerable variety in texture and colour, the latter depending on the percentage of iron. They not unfrequently contain a large quantity of clay, and are then apt to cake and harden, but without the excessive fissuring noticeable in purer clays. These sandy beds are frequently found overlying the highly ferruginous beds and form to a great extent the soil of the laterite areas."

The farm soils are all derived from alluvial deposits, probably estuarine, the characteristic silicious sands covering the greater part of its area, with beds of black clay below the surface at varying depths; the latter occasionally crop out. A ridge of metamorphic rocks runs through the southern portion of the farm from south-west to north-east, protruding in two or three places.

NATURAL VEGETATION is scanty, as might be expected from the character of the climate and the nature of the soil; the latter also checks the full growth of trees and shrubs. In the following list the chief plants found growing wild are mentioned, some few of them being cultivated plants:—

Natural order.	*Plants.*
Anonaceæ ...	Anona squamosa.
Papaveraceæ ...	Argemone Mexicana.
Capparidaceæ.	Gynandropis pentaphylla
	Polanisia icosandra.
	Capparis horrida.
Malvaceæ ...	Abutilon Indicum.
Byttneriaceæ ...	Guazuma tomentosa.
Meliaceæ ...	Azadirachta Indica.
Aurantiaceæ ...	Feronia elephantum.
Oxalidaceæ ...	Oxalis corniculata.
Zygophyllaceæ...	Tribulus lanuginosus.
Xanthoxylaceæ...	Toddalia aculeata.
Rhamnaceæ ...	Zizyphus jujuba.
Terebinthaceæ.	Anacardium occidentale.
	Mangifera Indica.
Asclepiadaceæ.	Asclepias gigantea.
	Dæmia extensa.
	Tylophora asthmatica.
	Hemidesmus Indica.
Convolvulaceæ.	Ipomœa pescapræ.
	„ pestigridis.
Solanaceæ ...	Physalis Peruviana.
	Solanum Jacquini.
	„ Indicum.
	„ trilobatum.
	Datura alba.
	„ fastuosa.
Pedaliaceæ ...	Pedalium murex.
Amarantaceæ.	Amaranthus tristis.
	Achyranthes aspera.
	Ærua lanata.
	Alternanthera sessilis.
Euphorbiaceæ.	Phyllanthus niruri.
	Euphorbia pilulifera.
	Jatropha glandulifera.
	Acalypha Indica.
Moraceæ ...	Epicarpurus orientalis.
Palmaceæ ...	Phœnix sylvestris.
	Borassus flabelliformis.
	Cocos nucifera.

Natural order.	*Plants.*
Pandanaceæ ...	Pandanus odoratissimus.
Liliaceæ ...	Sanseviera Zeylanica.
Commelynaceæ .	Commelyna Bengalensis.
Leguminosæ.	Acacia Arabica.
	Parkinsonia aculeata.
	Inga dulcis.
	Tamarindus Indica.
	Poinciana pulcherrima.
	Abrus precatorius.
	Cassia absus.
	Tephrosia purpurea.
	Clitoria ternatea.
	Crotalaria (several species).
	Indigofera ennecaphylla.
Myrtaceæ ...	Psidium pomiferum.
	„ pyriferum.
Lythraceæ ...	Lawsonia alba.
Portulacaceæ.	Portulaca quadrifida.
	„ oleracea.
	Trianthema obcordata.
	„ decandra.
Passifloraceæ ...	Passiflora fœtida.
Cucurbitaceæ ...	Coccinia Indica.
Rubiaceæ ...	Hedyotis umbellata.
	Morinda citrifolia.
	Spermacoce hispida.
Compositæ...	Eclipta prostrata.
	Wedelia calendulacea.
	Vernonia cinerea.
Graminaceæ.	Cynodon dactylon.
	Poa plumosa.
	Eleusine Ægyptiaca.
	Chloris barbata.
	Andropogon contortus.
	„ Martini.
	Aristida setacea.
	Bambusa arundinacea.
	Saccharum spontaneum.
Cyperaceæ ...	Cyperus rotundus.

The *Leguminosæ* and *Graminaceæ* are well represented; and amongst the plants of the former order may be noticed the *Abrus precatorius*, or wild liquorice, the seeds of which are used by native druggists and jewellers as weights (each seed weighing about 2 grains): they possess irritant properties and the roots abound in sugar. From the *Andropogon Martini* a fragrant oil is obtained by distillation, known as *Roussa* oil. The *Saccharum spontaneum*, or thatch grass, can be identified at a distance by its splendid plume-like panicle of silvery whiteness.

The two varieties of *Datura* are virulently poisonous, but the other *Solanaceæ* are edible.

The fruit and timber trees are mostly common ones, such as the custard-apple, guavas (two varieties), bhere, wood-apple, cashewnuts and mangoes, with the margosa and bastard cedar; besides which a useful plant (*Epicarpurus orientalis.*—Tamil perayam) is common and grows wild and has attracted some attention lately from the property its juice possesses of coagulating milk and has been experimented with for the purpose of making cheese.

The *Asclepias gigantea, Dæmia extensa, Tylophora asthmatica* and *Hemidesmus Indicus* or country sarsaparilla, all grow wild: the first two yield fibre, and all of them are well known for their medicinal properties, particularly the last-named, which must be considered a valuable plant, if we are to judge by the immense quantity of its roots which are annually used in the treatment of disease both by European as well as native practitioners.

The *Hedyotis umbellata* (Indian madder or cheyroot) is a very common, small, white-flowered plant, the root of which furnishes a dye much prized by the natives. The bark of the root of the *Morinda citrifolia* gives a scarlet dye, and the leaves of the *Lawsonia alba*, which is plentiful, are used in dyeing skins.

The *Sanseviera Zeylanica* is a good fibre plant and is common, as also is the screw-pine. The only palms are the wild date, the palmyra, and the cocoanut. The other plants found are for the most part field weeds, and are widely spread over the whole farm; many of them come out in the cold and disappear in the hot season, but the greater number persist throughout the year and are very troublesome. The worst and commonest is perhaps the *Cyperus rotundus* which it is almost impossible to exterminate owing to the character of its roots.

Climate and Meteorology.—The climate of the district is good as compared with that of many other parts of the Presidency; for the great heat is considerably lessened by the sea breezes which blow over it, and the rainfall is more considerable than in other neighbouring districts. The following table gives the average data of the meteorology of Madras from the records of the Observatory; the situation of which is latitude 13° 4′ N. longitude 80° 15′ E.; it is about 3 miles from the farm and the figures therefore give a general idea of the nature of the climate:—

Months.	Reduced atmospheric pressure.	Temperature of air.	Temperature of evaporation.	Percentage of humidity.	Greatest solar heat in vacuo.	Maximum in shade.	Minimum in shade.	Minimum on grass.	Rainfall in inches.	Wet days.	General direction of wind.	Daily velocity in miles.	Percentage of clear sky.
April ...	29·824	84·3	77·4	74	139·0	92·7	77·4	74·3	0·71	1	S.E. by S.	190	60
May ...	29·730	87·2	78·2	67	140·5	97·6	81·0	78·6	2·07	2	S. by E.	229	60
June ...	29·698	87·0	76·4	62	135·0	98·2	80·9	78·3	1·99	7	S.W. by S.	218	35
July ...	29·716	85·0	75·7	66	133·0	95·6	79·0	76·5	3·81	12	S.W.	207	35
August ...	29·749	83·6	76·0	71	133·1	93·2	77·6	74·8	4·53	12	S.W. by S.	180	31
September	29·774	83·1	76·0	73	136·5	92·1	77·3	74·4	4·83	10	S.W. by S.	160	36
October ...	29·841	80·8	75·5	79	133·3	88·3	75·6	72·6	10·99	12	East.	124	43
November	29·933	77·5	72·6	79	131·5	84·0	72·5	69·1	13·17	13	N.N.E.	168	43
December	29·979	75·3	70·2	78	133·6	82·1	70·2	65·7	5·10	7	N.N.E.	179	49
January ...	29·995	74·8	68·9	75	134·0	82·8	67·9	62·4	·99	2	N.E. by E.	149	64
February ...	29·962	76·8	70·8	75	134·5	85·4	69·1	63·8	·30	1	East.	133	74
March ...	29·904	79·9	73·5	74	136·5	88·4	72·0	67·6	·45	1	S.E.	151	76

The figures show that with an average annual temperature of about 81·3 and a percentage of humidity of 73, the average rainfall is 48·94 inches distributed over 80 wet days. The rainfall, however, is very unevenly distributed, more than 50 per cent. of it falling between the middle of October and the middle of December; and from then until June there is seldom much rain, unless it be of a cyclonic character: cyclones however are not unfrequent, and often visit this coast in May; during one which burst here in 1877, 22·23 inches of rain were registered in 96 hours, 16·55 inches of which fell in one period of 24½ hours.

The temperature and state of the atmosphere varies very much with the time of year; during April, May, and June strong southerly and westerly winds commonly prevail, which are intensely hot and dry, withering up all vegetation and reducing the country generally to the appearance of a desert, in which operation the general want of trees, hedgerows and plantations greatly assists. Later in the year, after the burst of the south-west monsoon, occasional showers, commonly thunderstorms, render the air more and more moist until, before the change of wind to the north-east in October, the air becomes oppressive, and excessively damp. After the heavy rains at the latter end of the year the climate is cool and very favourable to agricultural operations; heavy dews invariably falling and so enabling the crops to perfect themselves. Were it not for the shortness of the season, and the uncertainty of the rainfall being fairly distributed, the climate would be very advantageous to agricultural pursuits; as it is, it presents many terrible obstacles in the way of the farmer; the weather in January and February however could not be excelled, usually, for harvesting operations.

Here, before referring to the rainfall registered on the farm, it will not be out of place to make a few remarks on the character of rainfall as it influences the agricultural capabilities of any locality, it being a

general custom to estimate them or the character of a season almost solely by the amount of rain that falls during the year. Although a heavy rainfall in a hot country generally betokens a good year, yet undue importance is often attached to it by persons who, looking only at the total amount of rain, make no allowance for the circumstances that modify the effects of the separate falls. The most important conditions which affect the value of the rainfall are the season at which it falls and the amount that falls in a given time. The effects of a stated amount of rain must vary considerably according to the season at which it falls and the duration of time over which the fall is distributed, and also whether it falls in the evening or morning. When a fall of an inch of rain is equally distributed over 6 hours in the cold season its effects must be much more beneficial than a fall of the same amount occurring during 6 hours in the hot season. In the first case the water will pass easily into the soil, which is always more or less friable at that time of year, and after passing into the soil will not be so easily evaporated, because the temperature is lower, the soil loose, and the surface more or less covered with crop; whereas in the latter case the water will only partially penetrate into the soil on account of its density, and will also be evaporated within a short time.

As regards a given amount of rain falling in a varying time, it is evident that if an inch of rain falls in an hour in one place and another inch at another place on the same day is distributed over 24 hours, the effects of the falls must vary greatly: in the first instance half to nine-tenths of the water that reaches the surface would flow off the ground, whereas in the latter the whole may under favourable circumstances pass into the soil. To this it must be added that the first-mentioned inch of rain will beat down the soil and render it otherwise unfavourable to the growth of plants. In both cases one inch of rain would be registered in a day. Heavier falls than an inch would do even more injury.

It is also often assumed that light showers of rain are more beneficial than heavy ones; this however can only be true to a certain extent. A light shower of rain is very beneficial to growing crops, especially when they cover the ground so as to prevent rapid evaporation, but altogether fails in having any effect on unploughed soil during the hot season. If at that time of year a shower of rain amounting to one or two-tenths of an inch falls in the early morning and is succeeded by a bright hot day, by the evening every trace of moisture will most probably be obliterated; and such an amount may even fall every morning during 10—12 consecutive days with no better results; whereas, if the amount of rain thus distributed over 10 or 12 days were precipitated during one day only, the effect would be much more favourable; the moisture in the soil would then suffice to admit of field operations being performed and the soil would thereby be prepared to benefit from subsequent small showers of rain.

Allowing, however, that in no convenient manner could the register be kept in such detail as would be necessary to show the nature of the rainfall as fully as is referred to in the foregoing remarks, it is always advantageous to know the character of the falls and that can, to a certain extent, be shown by classifying the amounts registered as falls of under and over an inch. In India those below that amount are usually very light and not of very much service, unless they come

when the soil has been already thoroughly saturated but dried again on the surface, or during cloudy weather.

The following table gives the averages monthly registered at Saidápet worked out on this system :—

—	—	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	Total.
Total ...	1. Rainfall—inches ...	2·36	4·01	4·82	5·89	11·54	14·97	4·50	·59	·73	·25	·28	3·25	53·19
	2. Rainfall per cent. of yearly total ...	4·44	7·54	9·06	11·07	21·70	28·14	8·46	1·11	1·37	·47	·53	6·11	100·00
	3. Wet days	5·93	9·00	9·79	7·79	11·78	12·57	5·21	1·36	·50	·50	·50	1·71	66·64
	4. Wet days per cent. of yearly total ...	8·90	13·51	14·69	11·69	17·67	18·86	7·82	2·04	·75	·75	·75	2·57	100·00
	5. Average daily fall in each month per wet day—inches.	·4	·44	·49	·76	·98	1·18	·86	·43	·15	·50	·56	1·90	...
In falls of under 1-inch.	1. Rainfall—inches ...	1·35	2·16	2·51	2·00	2·32	3·13	1·32	·29	·16	·16	·16	·31	15·87
	2. Rainfall per cent. of yearly total. ...	2·54	4·06	4·72	3·76	4·36	5·88	2·48	·54	·31	·31	·31	·58	29·85
	3. Number of falls ...	5·36	7·93	8·50	5·93	7·71	8·07	3·78	1·14	·29	·43	·43	1·07	50·64
	4. Do. per cent. of yearly total ...	8·04	11·93	12·75	8·90	11·57	12·11	5·67	1·71	·43	·64	·64	1·60	75·99
	5. Average amount of each fall—inches.	·25	·27	·29	·34	·30	·39	·36	·25	·55	·37	·37	·29	...
In falls of over 1-inch.	1. Rainfall—inches ...	1·01	1·85	2·31	3·89	9·22	11·84	3·18	·30	·57	·09	·12	2·94	37·32
	2. Rainfall per cent. of yearly total ...	1·90	3·48	5·34	7·31	16·34	22·26	5·98	·57	1·06	·16	·22	5·53	70·15
	3. Number of falls ...	·57	1·07	1·29	1·86	4·07	4·50	1·43	·22	·21	·07	·07	·64	16·00
	4. Do. per cent. of yearly total ...	·86	1·58	1·94	2·79	6·10	6·75	2·15	·33	·32	·11	·11	·97	24·01
	5. Average amount of each fall—inches.	1·77	1·73	1·79	1·39	2·26	2·63	2·22	1·36	2·71	1·29	1·71	4·59	...

Although these figures bear out the general remarks already made regarding the distribution of the rainfall, they also afford some further information on the subject. Thus the year may be divided into different periods of unequal length according to the nature of the rainfall and the results summarized as follows, taking June as the beginning of the agricultural year :—

During period.	Average percentage of annual					
	Rainfall.			Wet days.		
	In falls of		Total.	With falls of		Total.
	Under 1 inch.	Over 1 inch.		Under 1 inch.	Over 1 inch.	
I. Of light rains coming from the south-west —June to September.	15·08	17·03	32·11	41·62	7·17	48·79
II. Of heavy rains coming from the north-east — October to December	12·72	45·58	58·30	29·35	15·00	44.35
III. Of little rain—January to April	1·47	2·01	3·48	3·42	·87	4·29
IV. Of exceptional cyclonic rain—May	·58	5·53	6·11	1·60	·97	2·57
Total ...	29·85	70·15	100·00	75·99	24·01	100·00

Though it is undoubtedly convenient to make up each month's rainfall separately, in no country with a climate at all like that of Southern India are such averages of great use. The period is far too long; extremes of drought and flood may easily be experienced in a single month, and yet the rainfall registered be still above the average. A period of a week is probably long enough to group together or at the most a fortnight. In the following table the rainfall registered at Saidápet is so arranged and it may be remarked here that the 13th week coincides with the last days of June; the cyclonic period of May ranges from about the 5th to the 8th week inclusive; and the period of the north-east monsoon rains from about the 29th to the 37th week.

Week.	Rainfall.	Wet days.	Rainfall.	Wet days.	Fortnight.	Week.	Rainfall.	Wet days.	Rainfall.	Wet days.	Fortnight.
1st	·15	·14	·16	·28	1st	11th	·97	1·50	1·18	2·64	6th
2nd	·01	·14				12th	·21	1·14			
3rd	·04	·14	·04	·14	2nd	13th	·50	1·78	1·26	3·42	7th
4th	...	...				14th	·76	1·64			
5th	1·01	·42	1·09	·63	3rd	15th	·84	2·14	1·85	3·99	8th
6th	·08	·21				16th	1·01	1·85			
7th	·17	·21	2·12	·92	4th	17th	·77	2·28	1·87	4·70	9th
8th	1·95	·71				18th	1·10	2·42			
9th	·14	·42	·74	1·70	5th	19th	1·21	2·64	2·47	4·85	10th
10th	·60	1·28				20th	1·26	2·21			

Week.	Rainfall.	Wet days.	Rainfall.	Wet days.	Fortnight.	Week.	Rainfall.	Wet days.	Rainfall.	Wet days.	Fort night.
21st	·81	1·92	2·13	4·34	11th	37th	1·43	1·35	1·89	2·20	19th
22nd	1·32	2·42				38th	·46	·85			
23rd	1·66	2·21	2·98	4·21	12th	39th	·51	·51	·82	1·01	20th
24th	1·32	2·00				40th	·31	·50			
25th	1·44	1·35	2·40	2·63	13th	41st	·06	·21	·11	·56	21st
26th	·96	1·28				42nd	·05	·35			
27th	2·36	2·57	4·36	4·71	14th	43rd	·25	·35	·38	·56	22nd
28th	2·00	2·14				44th	·13	·21			
29th	2·67	3·14	5·98	6·28	15th	45th	·49	·35	·49	·35	23rd
30th	3·31	3·14				46th	...	...			
31st	2·58	2·35	5·66	5·27	16th	47th	·17	·07	·27	·21	24th
32nd	3·08	2·92				48th	·10	·14			
33rd	3·73	3·28	7·80	6·20	17th	49th	·05	·21	·05	·21	25th
34th	4·07	2·92				50th	...	...			
35th	3·59	2·50	4·77	4·07	18th	51st	·14	·21	·14	·21	26th
36th	1·18	1·57				52nd	...	...			

To those who are interested in the subject a glance at the tables in appendix I, showing the rainfall in detail week by week and month by month for the past 14 years, will reveal the point remarked on above. Thus in 1872-73 there is nothing in the monthly returns to show that the weather experienced was very unfavourable, yet, in referring to the weekly returns for the same period, it will be seen that, from the 38th week up to the end of the year, there was only one week in which any rain fell. Again, in the following year in the month of December 10·9 inches were registered on 5 wet days, and though the amount is nearly double the average, yet the crops that year actually suffered severely from drought in that month, for after the fourth of the month on only one day was rain registered; the weekly return brings this out clearly.

The Farm Estate, as shown in the map, stands about 20 feet above sea level and is a triangular block of land divided into two nearly equal portions by the waste water channel of the Mylapur tank, which runs nearly from west to east through it. The total area is 276·02 acres and is sub-divided as follows:—

Field numbers.	Plantation numbers.	Area occupied by: Grass land.	Arable land.	Fruit and fuel trees.	Otherwise.
1	...	2·98	...	...	...
......	I	...	...	6·63	...
2	II	...	...	1·62	...
3	...	3·94	...	...	...
4	...	...	5·84	...	...
5	...	·94	...	...	...
10	...	...	4·25	...	...

Field numbers.	Plantation numbers.	Area occupied. Grass land.	Arable land.	Fruit and fuel trees.	Otherwise.
11	...	...	2·96	...	...
12	...	...	3·43	...	...
13	...	...	2·73	...	...
......	III	...	...	8·14	...
......	IV	...	...	4·26	...
14	...	...	1·33	...	...
......	V	...	...	10·66	...
......	VI	...	...	5·95	...
15	...	...	6·48	...	...
......	VII	...	...	2·54	...
16	...	...	2·85	...	...
17	...	...	1·83	...	...
......	VIII	...	...	3·82	...
18	IX	...	...	4·59	...
......	X	...	...	3·73	...
......	XI	...	...	12·71	...
21	...	...	3·10	...	...
......	XII	...	...	3·50	...
......	XIII	...	...	3·27	...
26	XV	...	...	7·33	...
25	XIV	...	...	1·91	...
24	XVI	...	...	8·48	...
22	XVII	...	...	1·20	...
23	...	...	8·19	...	...
28	XVIII	...	...	6·71	...
27	...	...	8·19	...	...
......	XXIII	...	...	2·37	...
......	XXII	...	...	4·23	...
29	...	...	2·74	...	...
30	...	...	2·05	...	...
......	XXI	...	...	1·97	...
31	...	...	1·58	...	...
32	...	...	4·76	...	...
33	...	...	2·36	...	...
......	XX	...	...	1·36	...
......	XXV	...	...	·81	...
34	...	...	2·15	...	...
......	XXIV	...	...	·51	...
......	XXVI	...	...	2·18	...
35	...	...	1·50	...	...
36	...	...	2·94	...	...
37	...	...	2·92	...	...
River bed under cultivation		...	2·86	...	...
Roads, drains and channels		...	...	...	19·92
Village-site		...	...	...	3·53
Commissariat slaughter yards, &c. ...		...	...	...	3·51
Farm yard and buildings		...	...	...	6·41
Botanical grounds		...	...	...	6·37
Agricultural college grounds		...	...	...	22·28
Veterinary hospital and ground ...		...	...	...	8·56
Students' cottages		...	...	...	2·83
Waste land		...	...	...	7·23
	Total ...	7·86	77·04	110·48	80·64

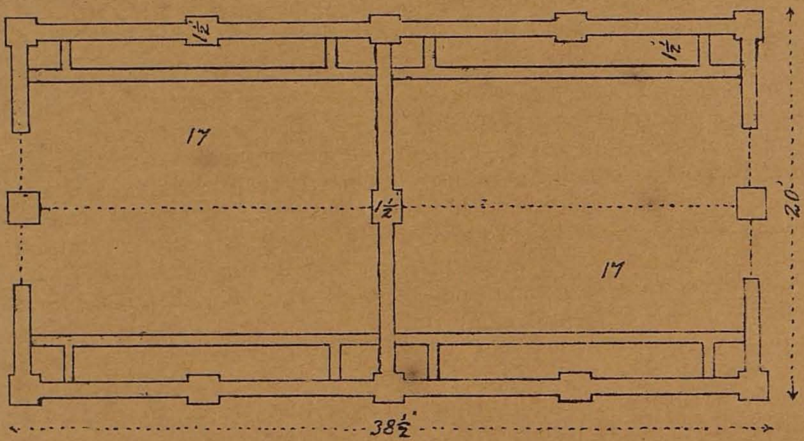
The land occupied by the Agricultural College, the farm buildings, &c., needs no further reference. The farm buildings, which consist of

PLAN

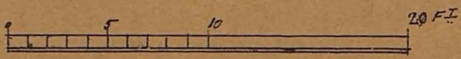
OF A

SET OF

CATTLE BOXES.



SCALE



a granary for the storage of seeds grown or collected for distribution, a barn for the reception of unprepared produce from the fields, storehouses for cattle food, &c., a chaffing and cotton-ginning room, sheep sheds, cattle sheds and dairy, a poultry house and other necessary accommodation, are most of them built of brick-and-mud walls, excepting in the case of open sheds where the pillars are of brick and lime, and are covered in all except two cases with tiles; they are situated at the south-east extremity of the farm, and, although not in the most advantageous position, are commodious and efficient. The Farm Overseer's quarters are in the yard.

The plan opposite shows a set of boxes in which all the working cattle of the farm are kept. A set consists of four boxes, each occupied by two bullocks. In the corner of each box is a square stand to receive the tub containing artificial food and along the outer edge is a trough for the fodder. The floor is sunk 2 feet below the level of the ground and manure is allowed to accumulate in the pit thus formed till it is 3 feet deep. The roof is supported on nine pillars and is tiled throughout. Boxes on the same plan, but of simpler construction, could be made by any ryot and his manure be well made under cover thereby.

The Botanical and Experimental grounds consist of three terraces rising by gradation from the river bank. The site was selected on account of its proximity to the College and its easy access from the main road of the farm, which constitutes its northern boundary; and also on account of the facility with which water for irrigation can be obtained from a water-lift close by, as well as from the channel forming its western boundary. The soil had nothing to recommend it, being in some parts indeed of the worst description met with on the farm, consisting chiefly of coarse sand; but it was thought that the application of clay, a bed of which was met with whilst excavating the channel mentioned above, and a liberal supply of manure, combined with judicious treatment, would bring the soil into a sufficiently fertile condition in a short time; an expectation which had been realized. The upper terrace is mainly used for conducting experiments on a small scale with plants regarding their ability to flourish in Southern India and requirements of which little is known; to raise specimen crops of valuable plants which cannot be easily grown on the farm; to acclimatize and propogate plants raised from imported seed; and also for conducting manuring experiments on a small scale. The second terrace was designed for growing crops on a larger scale; for performing manuring experiments; and for raising valuable fruit and other trees and shrubs. The lower terrace, being within flood level, is reserved for grass and less valuable varieties of fruit trees. Alongside is a small garden in which a collection of plants and shrubs is being gradually formed for use in the lectures on botany in the Agricultural College. Attached to the grounds also are four fields (Nos. 6—9) of the farm, which are partly being used for careful manuring experiments such as could not be easily conducted in the course of ordinary tillage operations and are partly occupied by specimens of useful trees, a collection of which is being formed. This area has recently been transferred to the Educational department.

The lands which are devoted to the farm proper have nearly all assumed their present form since 1874, for between that year and 1879

extensive levelling operations were going on and involved an almost entire remodelling of the fields both as regards boundaries and levels. This work was carried out with a view to future convenience and economy, but it has prevented the carrying out of delicate manuring experiments.

As will be seen from the map, a large portion of the estate is occupied by trees; some of these are old plantations of fruit trees (tamarinds, guavas, &c.,) but the major portions are casuarinas, which have been planted on all the poorest soils, and to which they alone are a suitable crop. These soils are chiefly sands of the driest and hungriest description, and the remaining soils of the farm vary therefrom up to sandy loams of fair value, and a small area of stiffish loam of poor quality and bad physical character. South of the channel which divides the estate into two nearly equal portions, there is about 5 or 6 acres of the last description on the south-east corner of the estate. A little to the north of this lies the best soil on the farm in fields Nos. 4, 10, 15, 14, and 11, but these are only sandy loams, whilst fields Nos. 12, 13, 16, and 17, are of inferior quality. The whole lie on a deep sand bed and are therefore dry and hungry. They contain little organic matter in their natural state, although they have improved in this respect of late years.

The following analyses, made about 12 years ago, before the soils had been ameliorated to any great extent by cultivation and manuring, give some idea of their natural poverty :—

Constituents.	No. 4 field (east side).		No. 1 field surface soil.
	Surface soil.	Sub-soil.	
	Per cent.	Per cent.	Per cent.
Alumina	4·420	2·060	3·240
Oxide of iron	1·800	2·900	1·350
Phosphate of lime	·240	·009	·120
Carbonate of do.	·700	·560	·310
Do. of magnesia	Trace.	Trace.	Trace.
Sulphate of lime	Do.	Do.	Do.
Chlorides	1·080	·720	·900
Moisture	2·760	1·420	2·090
Organic matter	2·500	1·740	2·120
Sand (silica)	85·900	90·400	89·870
Total ...	99·400	99·809	100·000

In the following table some information is given regarding the physical characters of two of the farm soils (Nos. 1 and 2), and together with it for the sake of contrast similar information regard-

ing a "black cotton" soil (No. 3) received from the Cuddapah district:—

——	Number 1.	Number 2.	Number 3.
	PER CENT.	PER CENT.	PER CENT.
Air dry soil contained water	·795	·92	6·4
Do. organic matter	2·40	1·90	5·38
Do. absorbed moisture from saturated atmosphere	·71	·19	3·67
Do. took up liquid water	25·95	22·92	30·79
	hours.	hours.	hours.
Required to take up water	1·4	3·75	6·25
	per cent.	per cent.	per cent.
Increased in bulk on saturation	...	...	6·66
Decreased in bulk on saturation	6·66	8·33	...
Retained of absorbed water after evaporation for 236 hours	3·60	2·62	14·81

These figures show how deficient the farm soils are in the power of absorbing and retaining both moisture and water; and the decrease in bulk which takes place on their saturation explains why they become so hard after drying and militates greatly against their being useful soils, for rain consolidates them, particularly on the surface, and thus the air is excluded.

It is also well to record the values placed on a portion of the land in 1865 by the Revenue Settlement department, which are embodied in the table below, it being understood that the numbers of the fields have all been altered:—

No.	Irrigated or dry.	Source of irrigation.	Description of soil.	Taram.	Rate per acre.	Area.	Assessment.
					RS. A.	ACS. CTS.	RS. A.
1a	Dry ...	Government well.	Permanently improved... 2 1	1	4 8	0 25	1 2
b	Do. ...	...	Black sand ... 5 1	5	1 8	4 21	6 5
2	Do. ...	...	Do. ... 5 2	6	1 4	15 51	19 6
3	Do. ...	...	Red loam ... 7 2	5	1 8	6 66	10 0
4	Do. ...	...	Do. ... 7 2	5	1 8	1 94	2 15
5	Perambokе.	...	......	...	...	0 67	...
6	Dry ...	Government well.	Permanently improved ... 2 1	1	4 8	0 68	3 1
7	Do. ...	...	Black loam ... 4 2	4	2 0	0 75	1 8
8	Do. ...	Government well.	Red loam ... 7 1	4	2 0	8 63	17 4
9	Do. ...	...	Do. ... 7 1	4	2 0	5 21	10 7
10	Peramboke.	...	......	...	...	5 18	...
11	Dry ...	Government well	Permanently improved ... 2 1	1	4 8	3 90	17 9
12	Do. ...	...	Red loam ... 7 1	4	2 0	4 11	8 4
13	Do. ...	...	Do. ... 7 1	4	2 0	3 93	7 14
14	Do. ...	...	Black sand ... 5 2	6	1 4	3 99	5 0
15	Do. ...	...	Do. ... 5 2	6	1 4	11 96	14 15
16	Do. ...	...	Black loam ... 4 2	4	2 0	5 59	11 3

No.	Irrigated or dry.	Source of irrigation.	Description of soil.	Taram.	Rate per acre.	Area.	Assessment.
					RS. A.	ACS. CTS.	RS. A.
17	Dry ...	...	Black loam ... 4 2	4	2 0	4 43	8 14
18	Do. ...	...	Black sand... 5 2	6	1 4	7 19	9 0
19	Do. ...	...	Do. ... 5 2	6	1 4	12 14	15 3
20	Do. ...	...	Red sand ... 8 2	6	1 4	2 61	3 4
21	Do. ...	...	Do. ... 8 2	6	1 4	1 47	1 13
22	Do. ...	...	Do. ... 8 2	6	1 4	3 34	4 3
23	Do. ...	Government well.	Do. ... 8 2	6	1 4	5 1	6 4
24	Do. ...	...	Do. ... 8 2	6	...	3 79	4 12
25	Peramboke.	...	......	...	...	9 42	...
					Total...	132 57	190 2

Abstract exhibiting the Area and Assessment of each class of soil.

Taram or class.	Rate per acre.	Area.	Assessment.
	RS. A.	ACS. CTS.	RS. A.
1	4 8	4 83	21 12
4	2 0	32 65	65 6
5	1 8	12 81	19 4
6	1 4	67 1	83 12
	Total ...	117 30	190 2
	Peramboke ...	15 27	...
	Grand Total ...	132 57	...

North of the channel there is at the extreme end a piece of land consisting of a fair sandy loam in fields Nos. 32 to 37, of which Nos. 35—37 are irrigable from the Mylapur tank ; next to this in fields Nos. 29—31, the soil is poorer and a portion of No. 30 is very much impregnated with salt ; No. 23 is a fair sandy loam and Nos. 21, 22 and 27 are poorer, whilst the remaining land planted with casuarinas is of the poorest description. The whole of the fields Nos. 21, 22, 23, 29, 30, 36 and 37, together with parts of others, is liable to submersion during floods from the adjoining river to the ruin of any crop then standing on the land. Besides the fields already noted the following are commanded by the Mylapur tank, Nos. 27, 21, 22, 23, 28, 29, and 30.

Water-supply.—The greater part of the estate is entirely dependent on rainfall and water raised by mechanical agencies, but there is in the northern portion about 20 acres irrigable from the Mylapur tank which lies just beyond the Mount Road where it forms the northern boundary of the farm. This supply is precarious, the tank being a shallow rain-fed one, and therefore is often only filled late in the season, or becomes exhausted before the crops grown under it have matured : there is no adequate control exercised over the flow of water from its numerous sluices, and part of the tank-bed being leased out for culti-

vation the renters of that portion are interested in and do anything they can to reduce the water level as rapidly as possible ; besides this the tank is far from being capable of retaining the supplies which often come to it and consequently it not unfrequently occurs that the waste water channel through the estate runs full for several days after rain has ceased to fall.

The supplies of water for raising by mechanical agencies are augmented on the southern side by an anicut, a dam about 4 feet high, constructed across the bed of the Adyar which keeps the water up all along the southern boundary of the farm. This water is led by two large channels into the centre of the southern section, one channel being on the west and the other on the east of it. On the banks of them several water-lifts are placed. Besides these, in this portion of the estate there are two lifts direct from the river, and one excellent well which has never run dry in the longest drought. Altogether in this portion of the estate with the present water-lifts about 25 acres could be irrigated by these means, but on so dry and sandy a soil irrigation of this description with hired labour must always be unprofitable ; for instance, sugar-cane grown on the farm soils has been found to require 100–120 waterings, in general less than half that number sufficing ; it is however necessary to carry it on to keep crops before the students of Agricultural College and also to raise fodder for the stock kept. In addition to the above area 3 or 4 acres of the river bed are frequently planted with paddy and are irrigated by gravitation or by baling according to the level of the water in the river.

Below the anicut, where the Adyar forms the eastern boundary of the estate, the water is salt and within tide-flow when the river bar is open. It has of late years been maintained at a higher level than previously and thereby makes a swamp of part of the river bed, and this, it is believed, has had an injurious effect on the healthiness of the estate for residence. The water in this part of the river is of course useless.

In the northern section the subterranean water-supply is much inferior to that on the southern half, and the land not nearly so well situated for its use ; there are three inferior wells capable of irrigating about 6 acres precariously and one small pond with a still more precarious supply. In this portion the supply might be considerably improved, but the land lies so far from the buildings and is so badly situated for supervision that it has hitherto not been developed.

CHAPTER II.

THE PREPARATION AND TILLAGE OF THE LAND.

The operations included under the above heading combine all the preliminary work necessary to the preparation of land for cultivation, and all the processes of tillage performed on the land before and during the growth of the crops raised thereon. Although the farm estate has been practically laid out afresh since it was first taken up for the purpose of an experimental farm, the work has never been of the nature of reclamation, but rather of remodelling. Considerable experience has, however, been gained in draining, fencing, tree-planting, and also a great deal on the performance of tillage operations. Irrigation has received some limited attention.

Drainage.—The unmerited ridicule with which the advice of a distinguished agriculturist * was received some years ago in this Presidency, when he ventured to advise our ryots to drain their paddy fields, is well known. Speaking generally, that advice was perfectly sound, and there is not the least doubt but that, had it been generally adopted, the country would have been richer by some millions than it now is. Irrigation and drainage must proceed together; the vast expenditure the State has incurred on irrigation works will never produce a fair return until the districts so watered are properly drained. The almost perfect irrigation arrangements of some districts, under present circumstances, act only to their injury. The command of an abundant supply of water throughout the year is the very reason why, in the neighbourhood of some of our best irrigation works, there is now so much valuable land abandoned. If it is the duty of the State to provide its tenants with the means of irrigating the land they occupy, it is equally its duty to see that proper drainage arrangements are made, so that the irrigation water they provide may not collect and stagnate in the soil to its injury, and to the injury of the health of the people who reside in the neighbourhood of land so irrigated. But, while large tracts of country have thus been rendered unproductive by the abuse of irrigation in the absence of proper drainage, there is in this Presidency a wide area of country that is injured by natural means, through an excess of water from rainfall or other causes. Not only does such water on retentive soils greatly retard field operations at the season when such work yields the largest returns, but it also prevents the free use of improved field implements, renders it impossible to adopt superior methods of cultivation, and confines the cropping of the land to the lower classes of plants. How frequently it now happens, when it is so important that every hour should be utilized for getting in the crops, that a heavy fall of rain puts an entire stop for days to all field operations on our retentive soils, by making the land unfit to carry cattle and implements, until evaporation has again rendered them sufficiently firm for the cultivating operations to be proceeded with.

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* The late Marquis of Tweeddale, Governor of Madras.

The great desire of the intelligent cultivator is to commence operations on his soil as soon as possible after the rains have first moistened it sufficiently, and to get it tilled and sown without loss of time, in order to secure the full advantage of the growing weather for starting his crops. On a good deal of the stiff land of this Presidency nothing can be done in working the soil until a week or more after a heavy fall of rain, and frequently by the time that the land is in a state fit for being worked, the weather has undergone a complete change, the air having become dry, and the sky clear and cloudless—conditions which are anything but favourable to the success of newly-sown crops. On the other hand, similar land when properly drained will generally be in a fit state for cultivation within a day or two after heavy rain. Not only does an excess of water in a soil of a retentive character prevent the cultivators of such soils from taking full advantage of seasonable rains for getting in their crops, thus delaying and putting out of season all subsequent operations, but a large proportion of the seed sown under such conditions also invariably perishes, and another considerable proportion yields only undersized sickly plants, while the plants produced by the remainder yield but very poor returns; from having so much to contend with during their growth from weeds, which, owing to the wetness of the ground, cannot be regularly removed by the bullock or hand-hoe; from the absence of aëration in the surrounding soil, on account of the impossibility of working cultivators satisfactorily in a wet soil; and from the attacks of insects, and fungoid diseases—mildew, rust, &c.—which delight to feed on crops that are growing under unfavourable conditions. During a drought, crops on undrained soils are far more likely to suffer from it than those on a similar soil that is properly drained. At such a time undrained soils cake over, become hide-bound and full of cracks; while drained soils are loose and friable—conditions suited for the absorption of dew and watery vapour during the night—retain water readily, the whole body of the tilled soil being more or less porous, and, as the roots of the plants growing on such soils meet with no obstacle to their free passage, but rather encouragement to their growth, they naturally grow deeper into the soil, and are thus better protected from the hurtful influence of a scorching sun.

This much being certain, it was resolved to make some experiments in subsoil drainage. When this was first proposed, it was contended by some that, if water is so essential for the proper growth and development of field crops in Southern India, it would be exceedingly unwise to attempt to lessen the quantity of this element in our soils. It must be remembered, however, that no description of subsoil drains can remove from a soil the whole of the moisture it contains, nor any which could be of use to growing crops; there is always, even in the most perfectly drained land, a considerable quantity of water which no drainage can remove. In fact it has been truly said that the object of drainage is "not so much to get water out of the soil as into it," *i.e.*, to pass through it. It has been found again and again that a well-drained soil contains during a drought more moisture than an undrained soil of similar character and composition: there are many reasons why this is so; one is that drainage facilitates the working of the

soil by field implements, not only in the greater perfection of the work done, but also in affording a longer season in which to do the work under favourable conditions, and as a thoroughly tilled soil is always well pulverised and therefore more porous, its capacity for retaining water is greatly increased, as well as its ability to absorb moisture from the air. A proper seed-bed cannot be obtained in a soil in which there is stagnant water; for to cause the germination of seed and the healthy growth of plants atmospheric air must be present in the soil, and it cannot be there in a sufficient quantity when the soil is full of water. Further, a water-logged soil is always cold, not only on account of the great reduction of temperature caused by the evaporation of its water, but also because heat cannot penetrate into it. Tropical plants suffer very much when the temperature of the soil on which they are growing is much reduced.

Persons who are unacquainted with agriculture, as practised in this country, can form no idea of the enormous losses that the cultivators of badly-drained land suffer in a normally wet season. The money expended in draining an acre of land would be soon recovered; indeed, on many soils in from 8 to 10 years no doubt the entire cost with interest on capital would be repaid. There are, of course, soils that do not require to be artificially drained, being sufficiently well drained naturally; and artificial drainage is only necessary for the removal of such water as the land will not hold in suspension, or that of springs found immediately under it.

In this country deep cultivation is absolutely necessary in order to secure the full benefits that result from subsoil draining. A soil that is simply drained, the particles of which have not been separated and loosened under the influences of deep and thorough cultivation, cannot in a dry season be expected to take up much more moisture from the atmosphere than undrained land of the same kind in a similar mechanical state. The absorption of moisture from the air can only occur in porous soils into which it can pass freely; sun-dried, hard, compact soils being quite incapable of absorbing moisture from the air. As in this country, at night, the air near the surface of the ground is at certain seasons very heavily charged with moisture, it is especially necessary, in order to secure this, that our soils should be kept as open and as porous as possible.

Where, as in this neighbourhood, from 3 to 5, or even 16, inches of rain sometimes fall in 24 hours, not more than one inch of which may sink directly into the ground, it will always be necessary to provide surface drains for carrying off flood-water even where the subsoil drainage is perfect. Thus it is probable that the general introduction of subsoil draining must be deferred for a considerable length of time.

It has already been found that there are technical difficulties in this country which preclude the exact imitation of the practice of subsoil drainage followed in Europe. Cutting drains in such a manner as to get a proper bed for the pipes and to allow no room for their shifting can only be effected by skilled labourers with proper draining tools: but the Indian labourer has no inclination to use other tools for excavation than his time-honoured mamotty and crowbar; and if he

were really inclined to use the draining spade, in most cases he would not have the strength to wield it; moreover, the soil during the greater part of the year is seldom in such a state that it can be worked with the spade without the assistance of the crowbar or pickaxe. Considering these peculiarities, it is evident that wide drains with roughly worked bottoms very often cannot be avoided: but this difficulty may be overcome by allowing the people engaged in cutting the trenches to work in their own way while excavating to about four-fifths of the intended depth, and making the remainder of the excavation by the use of special tools, in order to secure the narrowest cutting possible. In this way a solid bed for the drain pipe will generally be secured. To neutralize the bad effects resulting from wide and badly formed drains, the use of collars on the pipes would be of good service; but the application of collars causes another drawback, viz., that the pipes encased in collars are frequently not well connected, because their perfect juncture cannot be so well attained when covered by collars as when without them, and as the collars must be made wide to admit of their use over pipes, which are neither quite circular nor straight, it follows that silt has easier access to the pipes encased in collars than to those without them. There is thus no other way left than to cover the ends of the collars with plastic clay.

The first experiment made in subsoil drainage was commenced early in 1873 in a field of nearly four acres, in which the soil is a stiffish loam, and was then of a sour soapy character, resting on a subsoil of a similar nature, and had been almost entirely unproductive during the five previous years. The land was formerly (before it became the property of Government) used for growing paddy, under the repeated cultivation of which it had been injured. When heavily seeded, there was generally a fair covering of plant up to the time the crop was about one-third grown, and the plants looked well as long as their roots were confined to the few inches of the healthy surface soil; but after this, when the roots got into the sour soil, there was little further growth, the plants became yellow and stunted, and gradually red from the attacks of the fungoid disease, "rust," and only an exceedingly small yield of inferior grain was obtained; it mattered not what crop was tried, the result was generally the same.

One portion of the field was drained with stone drains, and another with pipe drains; each portion being separately provided with a main drain and an outfall. On both plots the parallel drains were 3½ feet, and the main drain 4 feet deep, while the distance between each parallel drain was 24 feet. A year after laying it was found that the stone-drained plot had not been successfully treated: the discharge of water from the drains was never very great, and soon became exceedingly small, ultimately ceasing altogether. The drainage with pipes was at first most successful, and the land has been permanently ameliorated, and the qualities it possessed, inimical to plant growth, have been removed. In January 1878—just five years after the commencement of the experiment—the drains were opened and nearly every one found to be blocked with silt. This was probably due in great measure to the pipes not having been properly laid, and also to the fact that the cracks produced in the dry seasons, though much

smaller than those that appeared before the land was drained, being very large and many of them reaching down to the level of the pipes, would at the first heavy rain convey the water immediately to the pipes, the joints of which admitting the water at once, and with it any earthy matter held in suspension would also enter, and the silt once inside the pipes would be deposited there. Nevertheless, although the pipes have been in a great measure silted up, the main drain continues to discharge a considerable amount of water after heavy rains. This is probably owing to the formation of water-courses near the pipes by means of which the under water is conveyed through the drains and discharged at the outfall.

In 1875 another experiment was commenced; the results, though unsatisfactory on the whole, are instructive and are quoted as follow :—

"The plot, which measures 7,100 square yards or a little less than $1\frac{1}{2}$ acres, and constitutes a portion of field No. 21, is situated at a very low level; and owing to the treatment the land had undergone at the hands of the ryots who formerly held it, the physical conditions of the soil were so bad that nothing would grow on it. To reclaim the land draining was resorted to, but the prospect of success was not very great owing to the peculiarity of the soil and the low situation of the land. The subsoil consists chiefly of fine sand which, after the drains had been dug, was constantly driven into them by the water in forcing its way into the drain. The drains were allowed to remain open for several weeks before the pipes were laid to get rid of the water, which was oozing out from their sides, but it was impossible to get them dry and to obtain a firm bed for the pipes. The workmen, from their inability to work with draining tools, had to stand in the drains when digging them and when laying the pipes, and thereby made matters worse. Indeed the soil at the bottom of the drains had in some places more the consistency of a paddy bed prepared to receive seedlings than that of a trench ready to receive drain pipes. A layer of clay turf, which was laid at the bottom of the drains to serve as a bed for the pipes, could only partly neutralize the bad effects of the marshy bottom. This caused the pipes to sink unevenly and to become irregularly joined, thus allowing the ingress of soil.

"Bad though the execution of the work was, it would not have been sufficient to ruin the drainage in a short time, had it been possible to give a great fall to the pipes; but unfortunately little fall was available, the surface of the field being nearly level and only a few feet above the bed of the nullah into which the water was discharged. If the trenches could have been left open for some months longer, until they had run dry, a somewhat firmer bed for the pipes would have been obtained, but this practice, which in similar cases is often resorted to in Europe, cannot well be adopted in this country, because a shower of rain is usually much heavier here and therefore generally more destructive than in Europe, would not only cause the sides of the drains to fall in, but each drain, by acting as an open surface water channel, would quickly widen and assume the character of a nullah, and the field be much injured.

"The pipes used were manufactured on the farm. For the parallel drains 2-inch and for the main drain 4-inch pipes were used; they were laid at from 3 to $3\frac{1}{2}$ feet deep in the parallel drains, and from 4 to 5 feet in the main drain. As the field is nearly level, the pipes were not laid so deeply at the upper end of the trenches as at the junction of the parallel drains with the main drain, in order to provide more fall. The parallel drains were 25 feet apart."

Based on the experience thus gained, the following calculation of the cost of draining an acre of land 4 feet deep with drains 30 feet apart may be given :—

		RS.	A.	P.
Cost of cutting parallel drains, 467 yards	...	7	4	0
Do. main drains, 75 yards	...	1	8	0
Levelling drains, &c.	...	1	0	0
Cost of 1,400 2-inch pipes	...	12	8	0
Do. 225 4-inch pipes	...	3	10	0
Carting do.	...	1	6	0
Laying pipes and filling trenches ...	...	1	8	0
Outlet and contingencies	...	1	12	0
Total	...	30	8	0

This estimate would apply to a loamy soil of tolerably even quality, and the rent charge in such a case, at $7\frac{1}{4}$ per cent. on capital, would be Rs. 2-4-0 per acre.

The drains last-mentioned were opened in June 1878 and the pipes examined; they were found to be more or less silted up. The silt probably got into the pipes after the first heavy rain after they were laid. It was remarked that during the intervening period a striking improvement in the physical condition of the soil had taken place and was observed when the drains were opened. The soil, which before was of close texture, had become more open and friable and showed great amelioration. The subterranean water level was only about a foot lower than the level of the pipes, yet in most places the soil near the pipes appeared well aërated and free of any superabundance of water. Indeed the soil taken out from the drains had the appearance of one which has been subjected to tillage for a long time. The re-opening of the drains, which caused so much labour in the first cutting, was a comparatively easy task, this time no water being met with at any place.

As there were indubitable signs of the possibility of improving this land by drainage, it was decided to redrain it. To avoid the cause of the previous failure, a greater fall was given, which necessitated, however, the outfall of the main drain being placed at rather too low a level; and the top end of the drains was not sunk so deeply as before. By this means it was possible to give the main drain a fall of 2 and the parallel drains of $3\frac{1}{2}$ feet per 1,000. To prevent unequal sinking of the pipes and also as far as possible the ingress of soil, the junctures of the pipes were covered with collars, each 4 inches long; three deposit cisterns were built in the main drain to catch the silt, if any should enter the pipes; moreover the proper junction of the parallel and main drains was effected by using junction-pipes, that is, pipes which have the first pipe of the parallel drain made in one piece with the main drain pipe. The pipes of the parallel drains also branched off from that of the main drain from the top and not from the side as is often the practice; by this means earthy matter in suspension cannot be so easily deposited when entering the main drains, because the fall into it gives the water sufficient velocity to prevent silting. When redraining the land the old trenches were used,

which, however, had to be partially filled and the pipes previously used were again laid. The work was carried out by day labour; in opening the drains, one cooly could easily dig a drain 100 feet long $3\frac{1}{2}$ feet deep in a rough manner. The following figures exhibit the cost of redraining the land, exclusive of the cost of pipes :—

	RS.	A.	P.	
Opening 3,000 running feet of drain trenches and filling drain	10	15	6	
Building one outfall and three cisterns 6 feet deep	19	6	7	
Total ...	30	6	1	per acre.

The charge for labour was certainly very moderate, the cost being only 2·1 pies per running yard; it must, however, be borne in mind that the soil was in a very favourable state for digging and the weather very fine.

That the construction of deposit cisterns in the main drain was not superfluous was shown after the first heavy shower of rain in October, when 3·05 inches of rain fell, as it was found that the deposit then accumulated measured about a foot in depth in each cistern, and in one was so great that it filled the cistern to a much higher level than that of the pipe. A year later in the report for 1879-80, it was observed regarding this land :—

"The piece of land drained in the year 1875 and redrained last year gave satisfactory results at first, but during the heavy rains the water in the nullah, into which the drainage water is discharged, rose several times some feet above the outlet for several days. The flood-water entering the drainage pipes stopped their action, and water was repeatedly observed standing almost immediately over the pipes for several days after heavy rain. Soon after the first heavy rains in October, it was observed that the pipes discharged but little water, which flow after subsequent rains ceased entirely, although the water in the deposit cisterns had risen nearly to the level of the surface of the land, clearly indicating that the drainage was out of order. The stoppage was most probably caused by the backwater checking the current of the drainage water in the pipes and thus causing deposit of the silt previously kept in suspension as long as the water was in movement. In this case the experiment has not proved successful as an example of subsoil drainage, owing chiefly, if not solely, to the want of a proper outlet which in draining land should always be at a sufficiently high level to prevent any stoppage of the flow of the drainage water during any part of the year. But, although the drainage did not entirely fulfil the object for which it was undertaken, there can be no doubt that the piece of land has been greatly improved by the drainage. On a portion of it, which never previously produced fair crop, this year a very fine crop of gram was grown and a much better one than on the remaining part of the field."

The improvement referred to continues, although the drains are now practically inoperative. The results of above experiments are therefore decided as regards the benefit which subsoil drainage does to the soil, but as regards the means of carrying out such a system in this country much more experience must be collected.

Another piece of land, more favourably situated than that drained in 1875, has recently been subsoil-drained. Its area is one acre and the cost of putting in the drains was as follows:—

	RS.	A.	P.
Trenches—excavation	18	5	9
Outfall and cisterns, materials and labour ...	13	8	7
Open drain—excavation and turfing ...	2	15	6
Total ...	34	13	10

This is a portion of No. 1 field, where the soil is raw and tenacious. The parallel drains are laid 3 feet apart and about 4 feet deep, and the main drain from 4½ to 5 feet: collars were used on the pipes throughout. The soil was very hard, and had to be excavated with crowbars, so that the cost was high. In the first season the drains acted well and continued to discharge water up to the end of December.

The cost of manufacturing drain-pipes may be given from the experience gained on the farm; a small tile machine by Clayton and Shuttleworth having been used. The average for 2-inch pipes was as below:—

	RS.	A.	P.
Preparing the clay	0	8	0
Removing the clay to the machine	0	3	0
Screening the clay	0	12	0
Making the pipes	1	0	0
Rolling the pipes	0	14	0
Labour at the kiln	0	8	0
Fuel	4	0	0
Add 25 per cent. for superintendence, wear and tear of plant, breakages, &c.	1	15	3
Total Rs.	9	12	3 per 1000.

The average for 4-inch pipes was about Rs. 15 per 1,000. All the pipes, both 2-inch and 4-inch, were a foot long.

IRRIGATION.—Although it has not been possible, from the absence of the necessary facilities for the purpose, to carry out any accurate experiments in this practice, much valuable experience in the use of water has been gained.

It is frequently remarked by persons, who ought to know better, "that, if the Indian ryot knows but little regarding dry-land cultivation, he has nothing to learn regarding wet-land culture." This is a most serious mistake, for, as far as is known, the cultivation of irrigated land in this country is but little, if at all, superior to that of unirrigated land. To produce an average crop on a good soil, with the aid of an abundant supply of water often very rich in silt, is no test of the quality of farming practice; the question is whether this good soil could not, with half the quantity of water generally used, be made to produce as good results; in this way doubling the supply of water for irrigation, and at the same time improving the sanitary condition of the country and maintaining the productive powers of the soil over a longer period.

We do not require to make our lands into swamps, to enable us to get good results from irrigation, unless, indeed, we wish to confine our practice to the culture of low types of agricultural plants. Merely pouring water into a paddy-field, floored with an impervious subsoil, is not making the best use of irrigation. The water must pass through, and not merely into and over the soil. We want perfect filtration, by which the water will pass down through the soil, and away by subsoil drainage, either artificial or natural. Until we possess this, we cannot hope on ordinary wet land to grow high types of plants. Irrigation water, judiciously applied, enables a plant to utilize thoroughly the food in its neighbourhood, not only by rendering that food more fit for assimilation, but by bringing it within reach of its roots.

Of the amount of water used by the ryot for growing paddy there is little doubt that the volume varies from 8-12 feet in depth: in the Coimbatore district 12 feet deep is required; whilst in an experiment made in the Godávari district, carried out expressly to discover the amount generally used, a sheet of water an acre in extent and 9 feet deep, in addition to a rainfall of 26 inches, was taken to bring to maturity one acre of paddy, and this under the superintendence of Irrigation officers, whose presence undoubtedly contributed to lessen the quantity of water that would otherwise have been used. There is no reason to suppose that the ryot in the latter case was more greedy in the use of the water than other ryots, who are equally favourably circumstanced for getting a supply. The quantity used in other irrigation experiments, made by the Public Works Department, varied from 6 to 7 feet in depth in addition to the rainfall to mature a crop of paddy. Experience on the farm has proved that under moderately good cultivation, with a soil of fair average quality, a volume of water, about four feet in depth, is ample for the production of one crop of paddy. Not only does swamp irrigation cause an enormous waste of a valuable producing power, but it is highly prejudicial in many other ways: the health of the people is injured; the soil is rendered unfit for cultivation, except under semi-aquatic crops of low type; and the capabilities of our irrigation works are seriously lessened by the smaller area thus watered. No doubt irrigation water is partly used in such wasteful quantities in order to maintain the fertility of the land, which the ordinary practice of the ryot is the best method of destroying; there is no reason, however, why the use of this fertilizing agent should be confined to such small areas, for, if used economically, twice the area of land, even under paddy, might be irrigated, and for this plenty of manure could be obtained from other sources.

In irrigating lands under wells the ryot has learnt to be more careful of water, but the area so irrigated is but a small portion of the total arable area of the country.

Fencing.—The growth of live fences is an almost unknown custom in the Presidency and every one is acquainted with the bare appearance the country presents when passing through it. This might be greatly altered if the ryots could be induced to plant live fences around their fields, and such fences would be of use in many ways; they would protect crops from damage by trespassing cattle; they would moderate the force of the wind, and lessen the losses that are sometimes experienced about harvest time from the effects of storms;

they would render the herding of cattle and sheep unnecessary, and be of use in many other ways; but their chief value would be to afford fuel for domestic purposes, the cattle dung now used by the ryot as fuel being set free for use in a legitimate way.

There are many kinds of shrubs admirably adapted for forming fences under the various conditions met with in different parts of the Presidency, and of these the most generally useful is the corkapilly (*Inga dulcis*), which resembles the English hedge-thorn very much in general appearance, and which has been grown on a considerable scale on the farm. A hedge of this shrub can be raised with a very moderate expenditure of labour, it being only necessary to dig a trench about $1\frac{1}{2}$ feet deep and 12 inches wide along the line of the proposed fence, and to fill this trench with a mixture of good surface soil and any manure that is available; when this is done the seed should be sown, say, in three parallel lines at equal distances in the trench. If the seed is put down with the first showers of the monsoon, it will be unnecessary to use water; if, however, sowing is done in the dry season, which, perhaps, the ryot will find the most convenient time in the year, he having then no urgent field-work to engage his attention, it will be necessary to water regularly until the seedlings are at least one foot high; but good treatment is not lost on a hedge of this kind; a fence that is properly started is always the least costly to maintain in good order. This plant grows very rapidly and produces ornamental and tolerably effective roadside fences. It grows so rapidly, however, that it requires frequent cutting to keep fences of it in order—on the farm it being trimmed about three times a year; this is naturally a source of considerable expense where, as on the farm, appearances have to be considered, but it is to a certain extent a valuable characteristic in a hedge-plant for the country generally, in that by growing it a large supply of firewood may be easily and cheaply raised. There is, however, one very great objection to the plant for fencing purposes on arable land, and that is the manner in which, and the area of land over which, it throws out its roots. In making some excavations the roots of a fence not three years old were traced for a distance of 24 feet on the side, and near the fence the soil was full of roots. A plant that grows so rapidly must demand a good deal of the soil, and, as this one is so vigorous and always growing, it impoverishes the soil near where it is planted to such an extent as to render the growth of a good crop on the adjoining land almost impossible.

After the second year the hedge may be cut regularly once a year, and will yield a large quantity of excellent fuel. When established, a mile of such a fence under fairly good treatment in a climate similar to that of Madras will yield annually from 30 to 40 cart-loads of cuttings, most of which would be well suited for household use. The cutting should only be done after the monsoon, thus securing the fences when at their full height to protect growing crops from the ill effects of the high winds that prevail during that season.

Fences formed in the above manner may be easily transplanted if the roots have not grown too large, as the roots may be taken up and replanted in a trench, formed as in the case when seed is to be sown, with very little trouble, and the fences they make will generally be

useful in six months from the time of planting. Fences have also been successfully raised from seedlings grown in a nursery. In doing this the nursery was dug over about 1 foot deep and then heavily manured. The seed was then sown in lines 9 inches apart in small beds; after sowing the beds were watered at first every day, and after the seed had germinated every second or third day until the plants were about 6 inches high, when gradually the supply of water was diminished, and when about a foot high watering was discontinued. This stopped the growth of the plants, but they still remained green; they were then transplanted to form a hedge. In a few small beds enough plants were raised to form a hedge 500 yards long. Nearly all the plants grew after being transplanted; water being applied occasionally. By this means a cheap hedge can be raised very conveniently in a short time. The planting may be performed at any time during the dry season when there is little circulation of sap in the plants.

In 1876, a thorny shrub, known locally as "Killuvai" thorn, was obtained from Coimbatore, where it is used as a fence plant and makes excellent fences. It is propagated by cuttings which readily take root and at once form a fence. It grows slowly, has few and only small leaves, which also drop off in the dry weather, so that in one respect the plant is a failure as a hedge plant. It forms, however, an effectual barrier to cattle trespass, but does not thrive fully on the poor sandy soil of the farm.

Experiments have been made in the growth of the Osage orange (*Maclura aurantiaca*), which is highly valued as a hedge plant in America and Australia, being bushy in habit of growth and armed with formidable spines, but on the farm soils it has not flourished. The Kangaroo thorn, which is also used to a considerable extent in Australia for the same purpose, has also been tried, but, though it promised well at first, did not succeed.

The American aloe (*Agave Americana*) forms a very useful fence, but it is of no use as a fuel-producer or a break-wind. A fence of this plant may best be formed by raising a bank 3 or 4 feet high above the surface of the ground (the soil required for raising the bank being obtained by excavating a drain on both sides) and planting the top of the bank with aloes; the cost of such work may be about one anna a running yard, for a bank 3 feet high and 9 feet wide at the base and 2 feet at the top, including supplying the aloe plants, and turfing the sides of the bank. It has been found that such hedges can be raised at a much less cost than corkapilly ones, as they require little attention after being planted, and when once grown up are well adapted to prevent cattle trespass. Animals will certainly eat the leaves of the plant when young, but not usually to such a degree as to injure the fence. The leaves also contain a valuable fibre, which may be easily extracted.

A very useful fencing, for situations where something is required to prevent cattle-trespass only, has been made of rejected telegraph wire strained on wooden posts. It is however expensive.

Tree Planting.—The only tree which appears to find its favourite soil on the farm is the margosa or nim (*Melia azadirachta*). It springs up every where if land is left waste for a short time and flourishes on the driest sands. It is, when well grown, a very beautiful and

graceful tree producing a very good serviceable timber for all agricultural purposes, whilst the seeds yield a valuable oil. The babool (*Acacia Arabica*) also grows freely, as well as the corkapilly, already referred to as a hedge plant, on the damper low lying portions of the farm; the former yields a hard heavy wood which is very serviceable in constructing farm implements, and the latter grows rapidly and is very remunerative as a fuel-producer. The wild Cassia (*Albizzia lebek*) grows well, but is not so hardy as those previously mentioned; it produces a hard heavy wood most useful in cart building. The Tamarind (*Tamarindus Indica*), Guava (*Psidium, pyriferum* and *pomiferum*), Mango (*Mangifera Indica*), Custard-apple (*Anona squamosa*), blue plum (*Syzigium jambolanum*) which produces a useful timber as well as fruit, Illupei (*Bassia longifolia*) producing a useful oil-seed as well as timber, and the Cashewnut (*Anacardium occidentale*), all grow freely and well on the farm with moderate care in their early growth. The tree, however, which has been most largely planted is the *Casuarina muricata*, of which there are now plantations of all ages on the farm in a thriving condition. The following quotation from the report for 1881-82 shows how the tree flourishes on the poor soils of the farm :—

"At an auction sale held in February, 100 trees were sold for Rs. 194-4-0 or nearly 2 rupees per tree; the buyers cut down the trees and removed them at their own expense. None of these trees were over ten years of age. Some were under eight years. Another lot of ten trees were sold by weight; they weighed 3,796 lb., and the price obtained for them at Rs. 9 per ton, with one rupee obtained for the roots was Rs. 16-4-0, or Rs. 1-10-0 per tree. Of course, the trees cut down were the best in the plantations. The object in planting the land with casuarina trees was chiefly to improve the soil, and to utilize land which for arable tillage was almost worthless. The intention is to plant the land with fruit-bearing trees, such as guavas, mangoes, &c., as the casuarinas are removed."

The land which has been planted has generally been the poorest sandy soil and outlying awkward corners and small plots which are expensive to cultivate. The next quotation shows the system on which the seedlings are generally raised :—

"A large number of casuarina plants have been raised during the year on the farm. The seed was purchassd at the rate of As. 8 per pound from persons who collected it in the neighbourhood. The seed was sown in small beds, about 10 feet long and 5 feet wide; these beds were prepared just as if for sowing tobacco, and the seed was sown on the surface, and then covered slightly with some compost made of fine soil and well rotted manure, some cut-straw or refuse from the yard being spread over the beds to prevent surface crusting and to protect the seedlings from the sun. Usually about ½ lb. of seed was sown in one bed, from which about 1,000 plants were raised. The plants appeared above ground in about two weeks after sowing; they were frequently watered at first, but when about 6 inches high only occasionally, and they were fit for planting out when about three or four months old. The cost of raising 1,000 plants fit for transplanting was about Rs. 2, which is very moderate; the usual market price of plants being Rs. 5 per thousand; this cost even could be much reduced, if plants were raised on a large scale. On the farm about 60,000 casuarina trees were raised during the year; to raise them four coolies were employed for about four months in preparing the ground, sowing, watering,

weeding, &c. To raise twice the number of trees only an additional cooly would have been required, reducing thereby the charges per thousand considerably."

Various systems of planting have been adopted, but the following is an account of that which has been most generally adopted of late years :—

The plants were transplanted on cloudy days, the land having been prepared as follows :—after ploughing twice it was harrowed and ridged, the ridges being made as usual about 2 feet apart from centre to centre. The seedlings were planted on alternate ridges. A boy in advance marked off the ridges with a stick at every yard length; a man following with a hoe made a hole from 9 to 12 inches deep at the spot marked; a boy following laid a plant in each hole, and another man coming behind, after having filled the holes partly with fine soil, planted the trees, which were watered by women immediately after planting. In this manner each tree occupied about twelve square feet; the cost of planting including the first watering varied between 10 and 12 annas per thousand trees; which is certainly very low.

The ridges between the lines of casuarinas were sown with castor beans. Nearly all the trees planted took root, and, where some of them died, they have been replaced by fresh trees, and the whole promise to do very well. The castor beans germinated very well, but, as it was rather late when the seed was sown, the soil being very poor, and the weather unfavourable, the plants did not attain a great height; if the season had not been so very exceptional they would have grown large enough to afford shade for the trees and the yield of beans would have paid all the expenses for watering during the first year.

The trees were planted more closely than usual in this case, but this was done partly for the sake of the shade the trees will afford each other and thereby be able to protect themselves better from the sun than when planted far apart, though chiefly to induce the trees to grow straight and upright, it having been observed that, when casuarina trees are planted far apart, instead of developing a straight stem their main stem is sometimes liable to fork and to produce many side branches and no proper main stem, thus considerably reducing the value of the tree.

In giving each tree 12 square feet, 3,630 trees can be planted on an acre of ground, which would involve, according to the expenditure incurred in planting on this farm, an outlay for—

	RS.	A.	P.
Preparation of the land by the plough ...	3	0	0
Raising plants	7	4	0
Planting, including first watering	2	12	0
72 cart-loads of manure including carting and spreading	36	0	0
Total Rs.	49	0	0 per acre.

This cost for planting one acre is very moderate, but to it must be added the charges for watering, weeding, &c., for the first year, after which time the trees require but little attention. It is difficult to estimate the exact charge for watering, as it depends on the nature of

the weather; on the facility with which water can be obtained; and whether the soil is in good manurial condition, &c. Under favourable circumstances, especially when some other crop is raised between the lines of casuarinas for shading them, Rs. 20 may suffice, but, under unfavourable conditions, as much as Rs. 100 may be required for watering an acre during the first year after planting.

Besides the castor-oil plant, dholl (*Cajanus Indicus*) has been used as a shade plant, but is not found so serviceable, for if it grows well it gives too dense a shade.

A modification of the system described above has been tried more recently, of which the following is a description :—

The land is prepared for sowing in the usual way and then ridged up with ridges 2 feet apart, and the trees planted on every third ridge, and the other ridges are afterwards sown with castor or planted with guinea grass which occupy the land and produce some return whilst the trees are still small. The distance between the trees can of course be easily varied and should be altered with the quality of the soil, but it is far better to put in too many trees and not have to fill blanks caused by death afterwards than to plant too thinly and thus incur heavy expenses in this way, whilst it should not be forgotten that it costs but little more to water the larger number of trees if water is raised by mechanical agency, and the larger quantity of thinnings will go towards covering the first expenses.

In 1883 the following results were obtained in making a light thinning of a small plantation planted in 1878, the trees being barely 5 years old; only stunted, crooked and superfluous trees were taken out :—

Area of plantation	... ...	1·95 acres.
Trees left	... ...	2,329
Removed	... ...	554
Obtained...	Logs	3 tons 10 cwt.
	Roots	8¼ „
	Toppings	9 „

The value of the produce was about Rs. 35 and it will probably soon be necessary to thin heavily, and the weight then obtained will be very considerable per tree.

Another tope of 3·82 acres, planted towards the end of 1881 or early in 1882 has been recently thinned and gave the following outturn :—

Trees	... ...	2,129
Wood	... ...	8·72 tons.
Branches	... ...	3·20 „

The total cost of establishing a tope on this scale, 1,800 trees per acre, and watering freely in its early years is not more than Rs. 50 per acre, or about six pies per tree established.

In another tope measuring ·57 acres planted in 1879 the following thinnings have recently been cut out :—

Trees	... ...	267
Wood	... ...	3·45 tons.
Branches	... ...	1·11 „

One advantage arising from planting casuarinas on poor land is that the land itself is gradually improved by the large addition of organic matter from the fallen leaves of the trees, which during a year is very considerable. In a casuarina plantation aged four years, the weight of decaying leaves covering the ground was found to be as follows :—

	Area.	Weight.
	SQ. YDS.	LB.
Plot 1	54	34·5
„ 2	54	38·5
„ 3	54	39·0
„ 4	54	44·5

The average of these results shows that the land had a covering of leaves at the rate of about 1⅓ tons per acre. Below the covering of fallen leaves lies a thin stratum of black vegetable mould, the remains of previous sheddings of leaves.

The experimental growth of other trees of economic value has also been carried on as will be seen from the remarks below :—

The Locust or Carob Bean (*Ceratonia siliqua*).—In 1866 some seedlings of this tree were obtained and planted on a piece of land in a good situation on the farm, but until 1877 they never produced any fruit. The trees never grew to any size and latterly showed no increase and have all, excepting two which just continue to exist, been removed. The stunted growth can scarcely be attributed to the climate, for the trees did not seem to suffer even in the hottest weather, but was probably due to the fact that the soil on which they were growing is deficient in lime. The trees were planted in a line, which arrangement, owing to the habit of the tree, is unadvisable. The risk which must always attend planting the tree, owing to its being diœcious (the male and female flowers being borne on separate trees), and there being no method of ascertaining the sex of the plant until it flowers, was forcibly illustrated in this case, as of five trees planted only one of them turned out to be a female one. To overcome this, grafting the seedlings should be adopted, as by grafting from known female and male trees, a certainty as regards the sex of the trees can be depended on ; the grafts thus raised could afterwards be planted out at convenient distances, allowing a large number of female plants to each male one.

The value of the tree lies in the fleshy pulp which forms the covering of its seed ; the seed also is capable of becoming a useful food when split and steamed. The pods produced here were very inferior.

Areca-nut Palms (*Areca catechu*)—(Tam.) Camooghoo, Paak-maram ; (Tel.) Poka-chettu ; (Hind.) Sooparee.—In 1871 a quantity of areca-nuts were obtained from the Western Coast, a few of which were injured by heating on the way over, but most of them germinated. The seedlings were planted out on a piece of open ground, which had been well cultivated and manured, having good drainage both surface and subsoil ; they were watered when necessary, and the soil about them was kept open and free from weeds. For the first few months they

appeared promising; after this they gradually turned yellow and sickened, and one by one died off. Had they been planted under shade, more satisfactory results might possibly have been obtained, as the plants exposed to the full glare of the sun suffered most; on the Western Coast, where the climate is moister, it is usual to plant areca-nuts under the shade of plantains, but whether or not the scorching weather experienced here for six months in the year is against their general cultivation in this district, they certainly need too much attention to make them a remunerative crop where the labour required must all be hired.

Germination of Cocoanuts.—Attention having been directed, in several scientific journals, to the possibility of hastening the germination of hard-husked seeds by steeping them in solutions of different salts and acids, especially in solutions of sulphuric acid, an experiment was made to test whether the germination of cocoanuts could be hastened thus. For the experiment, ten fresh cocoanuts were treated as below for five days. On the 1st of December the whole of the nuts were planted in a piece of suitable soil, which was watered when necessary. On the 12th of March one of the nuts sent up a vigorous shoot; but, the others having failed to send up shoots, they were all dug up on the 31st of March, with the results stated below :—

Experiment.	*Result.*
Two nuts, steeped in water.	Both had germinated well, and produced vigorous shoots.
Two nuts, steeped in water, with 5 per cent. sulphuric acid.	One had germinated, the other was rotten.
Two nuts, steeped in water, with 10 per cent. sulphuric acid.	Neither had germinated, but both were in good order.
Two nuts, steeped in water, with 15 per cent. sulphuric acid.	One was just commencing to germinate, both were in good order.
Two nuts, not steeped.	One was just commencing to germinate, both were in good order.

As far as can be judged from this single experiment, steeping in acid solutions seems to retard rather than to facilitate the germination of cocoanuts, while steeping in pure water hastens it.

The *Pithecolobium saman*, or so-called "rain-tree," has been raised and been found to grow vigorously where it can obtain water. It may probably answer as a shade tree for pastures or similar purposes.

Eucalypti.—Various kinds of this tree have been raised. Regarding these the following remarks were recorded in 1884 :—

The *Eucalyptus* trees planted in the botanical garden five years ago continued to thrive. Of these the *tereticornis* has made the most progress and the *bi-color* the least as the statement below shows. All the varieties except *paniculata* and *hemiphloia* were obtained from Queensland through the Director of the Botanical Gardens, Brisbane, or the Acclimatization Society. The growth of the trees has been very great, but so has been the care bestowed on them. It remains to be proved whether they will stand ordinary treatment when put out in plantations. A considerable quantity of seed has been obtained from Australia for distribution in the districts, it being thought inadvisable

to trust to the seed of young immature trees for raising plants in this country.

Botanical name.	Common name.	Age, April 1884.	Largest specimen.				Remarks.
			Height.		Girth.		
			1882.	1884.	1882.	1884.	
		YRS.	FT.	FT.	IN.	IN.	
Eucalyptus tereticornis ...	Red gum ...	$4\frac{1}{2}$	$27\frac{2}{3}$	$46\frac{3}{4}$	11	20	One of the trees flowered in 1882, but did not seed.
Do. citriodora ...	Lemon-scented gum.	$4\frac{1}{2}$	$17\frac{1}{2}$	$39\frac{1}{4}$	8	15	Flowered and seeded.
Do. paniculata ...	Common iron bark.	$5\frac{1}{2}$	$26\frac{2}{3}$	32	17	17	The tree measured in 1882 was blown down.
Do. resinifera ...	Red or forest mahogany.	$4\frac{1}{2}$	$15\frac{3}{4}$	$25\frac{1}{4}$	11	18	
Do.	Yellow mahogany.	$4\frac{1}{2}$	$5\frac{3}{4}$	$25\frac{1}{4}$	$2\frac{1}{2}$	18	
Do. rostrata ...	......	$4\frac{1}{2}$	$17\frac{1}{3}$	$25\frac{1}{2}$	10	16	
Do. goniocalyx ...	Spotted gum ...	$4\frac{1}{2}$	$13\frac{1}{3}$	$23\frac{1}{4}$	7	12	
Do. siderophloia ...	Dark or broad-leaved iron bark.	$4\frac{1}{2}$	$18\frac{1}{2}$	22·0	7	11	
Do. bi-color ...	Black box ...	$4\frac{1}{2}$	$10\frac{1}{3}$	$18\frac{3}{4}$	6	10	
Do. hemiphloia ...	Common box ...	$5\frac{1}{2}$	24	...	15	...	Tree growing in 1882 cut down, being distorted.

Divi-divi (*Cæsalpinia coriaria*) has received some attention, and is apparently disposed to grow freely on the soils of the farm. Most of the plants hitherto planted are too young to bear fruit, but 16 bushes sown in the Botanical garden in 1879 gave seventy-eight pounds of pods in the year 1883.

Deep Cultivation.—Year by year experience of the results seen on this farm confirms the opinion, "that the value of deep culture can, for usefulness in India, be scarcely overrated." Shallow cultivation is the curse of Indian agriculture, and the man who can induce the ryot to add an extra inch or two to the depth of his arable land will be as much entitled to the gratitude of his country, as he who makes two blades of grass to grow where only one grew before. The usual system of dry land management in this Presidency, which allows of crop after crop being taken off the land without, as a rule, a particle of manure being used, and is content if the cultivation of the soil be confined to a surface-stirring of not above three inches, is most suicidal. The great object of the cultivator of dry land should be to enable his soil to retain as much water as possible without its being stagnant or being actually visible to the eye, *i.e.*, in a capillary or a hygroscopic state. He should take care that no water remains on the surface of the

land, and by deep ploughing and the liberal use of organic manures increase, as much as possible, the porosity of his soil. Instead of this, the result of the ryot's operations is that his soil is rendered as little porous as possible; his lands during the rains are flooded and swampy, while during the dry weather they are baked and cracked.

In referring to deep cultivation, deep ploughing is not at all necessarily referred to. *Deep ploughing* involves the inversion of the soil, *deep cultivation* only the deep stirring of it; the former is in many cases injurious, and should in no case be rashly attempted. On such soils, for instance, as those resting on a tenacious soapy subsoil, which in the process would be brought to the surface, *deep ploughing* would render the surface soil unproductive until physical and chemical agencies had brought it to a condition fit for the growth of crops; and it would be equally unwise to bring up to the surface, by working the plough more deeply, portions of a subsoil which is poorer than the surface soil, or that is otherwise calculated to injure the surface soil in its physical character: in some cases good land has been ruined for many years owing to a raw subsoil in which nothing would grow being brought to the surface. *Deep cultivation* on the other hand has almost always most beneficial effects; it is not so much that the outturn is enhanced, but that the soil is not so easily affected by climatic disturbances, affording a larger field for the roots of plants to search for their food in, and thus maintaining the average productive power over a much longer period. Unless more manure is used, no extra depth of cultivation can permanently maintain an increased outturn; the two things must go together.

On salt lands deep subsoil-ploughing must be very valuable; for by this means the soil is loosened to a great depth and the capillary tubes are so much enlarged that the injurious salts will be unable to rise to the surface; any also which have previously reached the surface will be washed down into the subsoil, and the surface soil be fitted for the growth of plants. Deep cultivation will always have more effect on strong stiff soils than on light ones; they are the soils that particularly need opening up. It is extremely probable that deep cultivation can, if universally followed where possible and efficiently performed, do, perhaps, more to avert famine in this country than almost any thing else; it would also, if adopted, greatly enhance the immediate producing capacity of the land, as our surface soils cannot but be in a very reduced condition for the supply of the requisite food for our crops. There is reason to believe that the result which has followed the breaking of the sod of the western prairies of America—a wonderful change and amelioration of climate, together with an increased rainfall and less violent variations of temperature—would take place in India, were our arable lands more deeply cultivated, and thus rendered absorptive of the rain-water which now, to so great an extent, flows away to the sea. The analogy between Indian arable soils and the unbroken hard-beaten sod of the prairie is very close in respect to their non-absorbent qualities. The fact that breaking up land reduces the flow of water off it is well known to tank-makers, and if the inefficient cultivation now practised has such effects, how much more might not real deep cultivation do? That land deeply stirred has a much

greater power of absorbing rain-water than if it be shallow tilled is a matter of common knowledge, and on the farm, since the tillage has grown deeper and more thorough, the manner in which the surface drains fill has altered considerably; formerly, and still if the surface of a field be unbroken, they filled almost instantaneously; now it requires a heavy persistent fall of rain to set them running, if the surface has only been broken.

During the drought of 1876 the advantages of deep cultivation were clearly shown on the farm; the most casual observer in looking at the crops could not have failed to note the remarkable superiority of the plants growing on the deeply tilled soil, compared with those growing on the head-lands of the fields and other shallow cultivated land. Without the aid of any irrigation water a crop of Sorghum saccharatum yielded 5,000 lb. of straw and 924 lb. of grain per acre; while crops of yellow cholum and Planter's friend yielded from 300 to 450 lb. of grain and 2,500 to 4,000 lb. of straw per acre, thus showing that by deep cultivation and good management in the driest seasons a fair supply of food for the people and fodder for the cattle of the country could be grown even on the inferior soils here dealt with. The following table gives some figures showing the effects of deep and shallow cultivation; the deep cultivation being in the body of a field, the shallow on its head-lands:—

During Growth.		Duration of Growth.	Nature of Cultivation.	Area of Plot.	Yield of Straw.	Yield of Straw per Acre.	Proportion.	Yield of Grain.	Yield of Grain per Acre.	Proportion.
Rainfall.	Wet Days.									
				S. YDS.	LB.	LB.		LB.	LB.	
·16	3	87 days.	Deep ...	16,027	11,456	3,459·6	100	221	66·7	100
			Shallow.	2,180	216	479·5	14	4·5	9·99	15

The whole field had been heavily manured throughout, and, if anything, the head-lands received more than their share of the manure. During the growth of this crop only ·16 inch of rain fell. The seed was sown after a week's dry weather, which followed a fall of 1·55 inches, before which there had been no rain at all for more than a fortnight. The head-lands were cultivated fully as deeply and as well as is the ordinary practice of the country; which, there is therefore no room for doubt, intensifies enormously the occasional deficiencies of rainfall we suffer from.

In 1882 a small experiment was made in field No. 11 in subsoiling. Six quarter-acre plots were selected and divided into two sets. The soil of the first is somewhat superior to that of the second set. Both sets of experiments clearly show the advantages that result from deep tillage. The crop, yellow cholum, was sown on the 17th of October, and the fodder was cut green on the 30th December:—

No. of Plot.	How Treated.	Produce.	Produce per Acre.	Proportion.
		LB.	LB.	
	First Set.			
I	Subsoiled to 12 inches	2,128	8,512	100
II	Subsoiled to 9 inches	2,056	8,224	96·61
III	Ploughed as usual 5 inches deep (not subsoiled).	1,484	5,936	69·73
	Second Set.			
IV	Subsoiled to 12 inches	1,814	7,256	100
V	Subsoiled to 9 inches	1,656	6,624	91·29
VI	Ploughed as usual 5 inches deep (not subsoiled).	1,530	6,120	84·34

That deep cultivation should be carried out by degrees and the subsoil plough be freely brought into use; and that only when an even texture and condition to a considerable depth has been gained may deep ploughing be resorted to, the remarks below, referring to work done on the farm in 1878, will show. The soil of the farm being mostly of a sandy or sandy-loamy character may generally, without running great risk, be ploughed deeply; a porous soil admitting easy access of atmospheric air being easily ameliorated, especially when liberally manured. The ill effects noticed were probably due to the surface soil being richer than the subsoil and ploughing it down caused temporary loss.

"*Trench-ploughing.*—The weather being favourable during August and September for field operations, nearly all the land prepared for cold weather crops at that time was ploughed to a depth varying from 9 to 14 inches. It was found that some of the ploughs obtained from Sweden of the English model are admirably adapted for deep ploughing, and they were nearly exclusively used for this purpose; indeed they were almost the only ones that could be effectively used, especially at a time when the soil had become dry and hard. Some of the ploughs turned a furrow 14 inches wide and 12 inches deep, thus moving 13 cubic yards of soil in every 100 yards travelled. The draught was necessarily heavy, and commonly two pairs of cattle were used, except when the pair of buffalo bulls were used, which on account of their great strength were able to do the work by themselves. Sometimes the soil was so hard that light iron ploughs could not penetrate into the soil and even a subsoil plough following these ploughs did not make good work, but, on using the heavy ploughs referred to with two pairs of cattle, the hard pan lying a few inches below the surface was broken through and a moist subsoil was sometimes turned up; in this case one deep ploughing effected more than two or three ploughings with a light plough.

"These ploughings no doubt were very beneficial to the land, but the effect on the first crop grown was not always good. At other times after a shower of rain, when the surface was too wet for ordinary ploughing, by ploughing deeply a drier soil was turned up from below, which on being mixed with that on the surface produced a sufficiently moist seed bed, and a

soil dry enough to admit other operations, such as harrowing, &c., being performed. By this means not only could sowing be earlier effected than would have been possible had the land not been so deeply ploughed; but the moisture thus distributed through a great body of soil was more fixed, it being well known, and has been shown in experiments made with various soils on this farm, that the rate of evaporation is much greater from a soil saturated with water than from one which is only moderately moist.

"There can be little doubt that the comparatively good yield of some of the crops raised last year under the adverse circumstances previously referred to must be chiefly attributed to deep ploughing, especially in cases where the subsoil had been in a measure prepared for it, by subsoil ploughing and heavy manuring in previous years. The beneficial effect of it was most strikingly exhibited in field No. 33, which had been twice deeply ploughed, in which a crop of horse-gram was sown on the 16th January. The seed germinated freely and the plants grew luxuriantly all over the field, except at the head-lands, which had been less deeply ploughed, and the soil of which had been more or less consolidated by the frequent treading of cattle. Close by, another field which had not been so deeply ploughed was sown with horse-gram at the same time. The seed in this case also germinated regularly but the plants ceased growing and perished soon after they appeared above ground on account of the insufficiency of moisture."

Tillage Operations.—The object of all such operations is "to secure a fine, moist, deep, and clean seed bed;" that is, to pulverize the soil thoroughly, thus opening it up to the disintegrating action of the atmosphere, and to remove and destroy all weeds as far as possible. The means adopted are *ploughing*, *grubbing* or *scarifying*, *harrowing* and *rolling*. The experience obtained in using the different implements required for performing these operations will be found in the next chapter.

Ploughing—as understood by the European farmer—signifies the inversion of the soil, and must not be confounded with the action of the plough (so called) of India, which is that of a *grubber* or *scarifier* which only stirs and loosens the soil. It is unnecessary to add any further remarks on the subject here as it is fully discussed below. The operation of *scarifying* has already been described as that of the Native plough, but even for this work that implement is considerably inefficient; the whole surface soil should be thoroughly loosened, stirred and mingled at one operation, and at the same time all surface weeds should be rooted out and left on the surface so that they may be destroyed by withering. *Harrowing* is an adjunct of ploughing in preparing land for seed-sowing by breaking down and intermingling the particles of the soil, whilst at the same time weeds are drawn to the surface, whence they can be removed if they are not likely to be destroyed by natural agencies. Harrowing is also resorted to for covering seeds after sowing them, and again in breaking down manure spread on the surface of the land. *Rolling* is most properly resorted to only for consolidating light land and smoothening the surface as a preparation for seed-sowing, but may also have to be adopted as a means of reducing rough land in preparing it for sowing, when the clods are not likely to be submitted to the more effective disintegrating action of atmospheric changes.

The cost of performing the abovenamed operations varies with the width of the implement used, the nature of the work done, and the

speed of the draught animals. The following figures show the experience gained on the farm in this respect :—

Nature of work.	Ploughing.	Grubbing.	Harrowing.	Rolling.
Cost of implements	Rs. 20	Rs. 35	Rs. 15	Rs. 10
Cattle required	2	2 large or 4 small.	2	2
Men required	1	1	1	1
Cattle hire	As. 8	As. 8	As. 8	As. 8
Coolie hire	As. 3	As. 3	As. 3	As. 3
Interest and wear and tear ...	As. 2-6	As. 3-6	As. 1-8	As. 1-4
Total daily cost	As. 13-6	As. 14-6	As. 12-8	As. 12-4
Area of a day's work ...	Acre $\frac{3}{4}$	Acres $2\frac{1}{2}$	Acres 4	Acres 4
Cost per acre	Rs. 1-2-0	As. 5-10	As. 3-2	As. 3-1

CHAPTER III.

IMPLEMENTS, MACHINES AND TOOLS.

The South Indian farmer, as is well known, has but a scanty supply of implements to assist him in his work. Throughout the greater part of the presidency he possesses only one—a so-called plough—with which to prepare his land for receiving the seed. In other parts he also makes use of a large scraper (*guntaka*), the action of which is still less effective than that of his plough. Besides these, the bamboo drill, sowing three or six rows of seed, is in use in some places, as well as an ineffective bullock hoe (*danthi* or *pápátam*); otherwise no implements are generally used either in preparing the land for sowing seed, or in cultivating between crops during their growth; in fact, except where the drill is used, the crops are sown broadcast and so no implements for after-cultivation can be used.

Ploughs.—The native plough (so-called) does not perform the work of a plough at all, but in reality that of a very badly constructed grubber. This implement can be made for about a rupee and a half by any one, so that in embarking in farming the ryot does not, like his European fellow-toiler, lock up any considerable amount of capital in the means of preparing the soil for the reception of his crops; but in no way does he show his blindness to his own true interests more clearly than in his adherence to his ancestral crooked stick, which he uses with so much ill-directed energy in scratching the soil which he has treated so ill, and which even to his illiberal management yields returns so disproportionately good.

It is only by devoting an altogether undue length of time to the work, and by the performance of an incredible amount of labour, that a ryot can, with his implement, reduce his land to good tilth. The section of the furrow made by the native plough is shown in the following diagram.

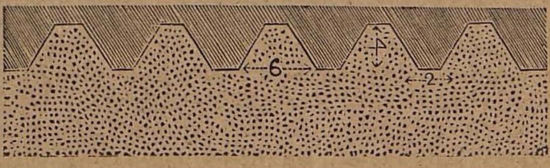

Fig. 1.

In this section the shaded portion roughly represents the soil that is moved when the land is once ploughed by the native plough. This is much less than it appears to be to a casual observer, for in reality less than one-half of the surface soil is moved when the plough passes only once over the field. This fact is well known to ryots, who endeavour to remove the ribs of unstirred soil by ploughing the field several times in different directions.

The next figures show how a furrow slice is cut and almost completely inverted by a plough of *European* or *American* design.

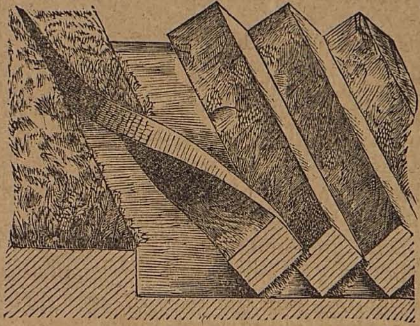

Fig. 2.

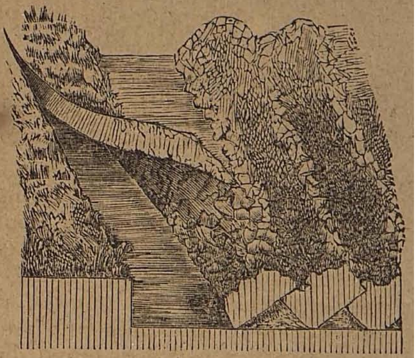

Fig. 3.

From the above diagrams it will be seen that in good ploughing with a real plough the whole of the surface soil, to the full depth ploughed, is moved, and the degree to which inversion is usually carried is also shown. The difference between the "rectangular" (fig. 2) and the "broken" (fig. 3) furrow simply lies in the condition in which the furrow slice is left after ploughing, and is effected by a difference in the form of mould-board; a long gradually curved mould-board giving the former, and a more abrupt one, set more at right angles to the line of draught, the other; the former involves the exertion of less force in drawing the plough through the soil than the latter, and is the form generally given by English ploughs, whilst American ploughs generally turn a broken furrow. The latter does not require so much harrowing, and leaves the slice in a better condition to benefit by the action of the air on the soil; but it is doubtful whether these advantages are in India, where the strength of the plough cattle is so small, sufficient to compensate for the increased draught of ploughs built for the purpose of doing such work.

Ploughs of different European patterns have been regularly used on the Farm for the past fourteen years and more. Both large and small ploughs have been employed, the former being found useful when the ground is so dry and hard that a light plough cannot penetrate it. Cattle and coolies work them well. Coolies readily learn the use of the plough; some are very good ploughmen, and are as proud of their skill as any English ploughman; indeed, some of them will turn as straight and regular a furrow as was ever seen in any champion ploughing match in England. A remarkable change has taken place in the observations of the ryots who come to see our operations; at first one of their greatest objections to our ploughs was that they ploughed too deep; but the chief one they now advance against them is their great cost in comparison with native ploughs. The seeming force of this objection will be better appreciated when it is stated that from ten to twenty native ploughs can be purchased for the price asked for one English plough.

It, however, will be allowed that the question for the consideration of the ryot, when about to buy a plough, is not so much the price that must be paid for it, as the cost of the work that the implement will perform: thus, if he can with an iron plough—making every allowance for labour, keep of cattle, for wear and tear, interest, &c.—turn over his soil at the rate of forty cubic yards for an anna, while with the country implement the cost of doing the same work is not less than two annas, it is evident that the extra cost of the iron plough will be recovered in a very little time on a farm of moderate size; indeed, the ryot who cultivates a holding with but twenty acres of arable land can, by substituting an iron for his native ploughs, save in a single season a sum equal to its first cost, and it will, with ordinary care, last many years. It has been found that for effect one English plough can do better work than three or four native ones; so that, allowing for a slightly better description of cattle being required for the former, it is evident that by being relieved of the expense of keeping up two or three pairs of draught bullocks, and of the pay of two or three coolies to drive them, the ryot would effect a saving such as has been pointed out, the difference in cost of up-keep of a good and of an inferior pair of cattle not being great.

It may not be out of place, however, to go more into detail on this point. An ordinary native plough does not usually cost more than a rupee and a half, while a European plough may cost from fifteen to twenty-five. At first sight, the native plough thus possesses a great advantage over the improved plough. But is this really so?

The test of the working capabilities of a plough is the amount of soil it is capable of turning over in a given time at a given cost. When a native plough is working under *favourable* conditions, the section of the furrow it makes is V-shaped and may be taken as five inches wide at the top and two at the bottom and four inches in depth; thus the area of the section is fourteen square inches. If the width of the furrow at the surface of the ground is five inches, and the furrows are close together, the plough in going over an acre must travel nearly twenty miles. But in one operation, only half of the land or less is moved, there being ribs of unmoved earth left between each furrow. To stir these also the plough must again pass over the land across the first ploughing, travelling another twenty miles; thus we have forty miles passed over in ploughing one acre to a depth of four inches, some portion of which still remains unstirred. From this, even granting that in two operations the whole of the surface soil can be stirred to a depth of four inches, the total quantity of earth moved per acre would be only 538 cubic yards, and this would occupy three native ploughs with cattle and drivers for a day; for, under average circumstances, a pair of country plough cattle will not travel more than thirteen or fourteen miles a day in ploughing. To arrive at the cost of doing this work, we may calculate as follows:—

	RS.	A.	P.
Three pairs of cattle at 6 annas a pair	1	2	0
Three drivers at 3 annas a day	0	9	0
Wear and tear of ploughs	0	1	0
Total Rs. ...	1	12	0

This would represent 307 cubic yards of earth stirred for a rupee.

A European plough, as has been shown, cuts a rectangular furrow slice. In *ordinary* ploughing, the furrow may measure nine inches wide and five inches deep, and thus the section has an area of forty-five against fourteen square inches, the area of the section of the furrow of the country plough. A fair day's work for a European plough is three-fourths of an acre. To do this the cattle must travel about eight and a quarter miles, excluding turnings at the headlands, and the quantity of earth turned over by one plough will be 487·5 cubic yards, against 538 cubic yards stirred by three country ploughs in the same time. Making the same calculations for this plough as those made above, the following results per acre are obtained :—

	RS.	A.	P.
One pair of cattle for 1⅓ day at 9 annas a day	0	12	0
One driver for 1⅓ day at 3 annas a day	0	4	0
Interest and wear and tear of plough (assuming that the plough will last ten years, charging repairs at 2 rupees per annum ; interest at 5 per cent., chargeable over 40 acres ploughed in the year) at 2 annas per acre	0	2	0
Total ...	1	2	0

In ploughing an acre we get 650 cubic yards of soil raised and turned over most efficiently at a cost of Rs. 1-2-0, or at the rate of 578 cubic yards per rupee, against 307 cubic yards per rupee when country ploughs are used. This calculation is extremely favourable to the country plough. The economy of time is of course still greater, and that is a very important matter at certain seasons.

In the following table the results of some trials recently made as to the capabilities of several ploughs are given, which clearly bring out the points alluded to above.

Ploughs.	Time occupied.	Area ploughed.	Rate of ploughing in a day of 8 hours.	Average depth of furrow.	Cubic yards of soil turned over per diem at this rate.	Cost of working and maintaining plough per diem supposing it to work 32 days per annum.	Cost of turning over 100 cubic yards of soil.	Proportionate cost.
	MINS.	ACS.	ACS.	INS.		A. P.	AS.	
Avery's Hindustan, first trial.	35	·1	1·3	5·5	961	13 6	...	...
Do. do. second do.	45	·1	1·06	5·5	784			
Average ...	40	·1	1·2	5·5	873	13 6	1·54	100
Massey's C.P., original ...	50	·09	·86	4·5	520	12 9	2·45	159
Do. C.P., improved ...	40	·09	1·08	5	726		1·75	11 3
Country, first furrow ...	105	·17	·43	4	*231	12 9	5·52	363
Do. second do. ...	82							

* Supposing the whole soil to be moved.

These figures speak for themselves. Massey's new C.P. and Avery's plough may be said to be equal in effect, as the pattern of the former was not new when used and Avery's was. The manner in which a real plough of even so rudimentary a nature as those tried excels the stick of the country is brought out in these figures with most startling effect, a result not fully anticipated, for it was not believed that, taking the favourable calculations as to depth for the country implement, it would have been shown to cost between three and four times as much to stir the soil on the same area of land with it as with a real plough.

Taking the rates of turning over the soil with

Real ploughs	1·75 anna per 100 cubic yards;	
So-called ploughs	5·50 annas	do.

and that the 20 millions of acres annually cropped in this presidency should be tilled to a depth of four inches, the cost of doing the work would be as follows:—

By using—

Real ploughs	about Rs.	1,17,64,000
So-called ploughs	do. Rs.	3,69,72,000

Saving by using former for a single ploughing, Rs. * 2,52,08,000

or, say, about Rs. 1-4-0 per acre cultivated, which saving in one year would more than suffice to repay to the investor the money spent in purchasing a real plough.

Besides the above-mentioned aspect of the question there is the effect on the land. With the real plough the slice is inverted, the soil thoroughly exposed, and weeds buried and thus destroyed.

It is true that a very considerable number of cultivators in this presidency could not raise even twenty rupees to buy a plough, yet there are thousands of them who can easily provide the money. And it must be remembered always that, to do the same work with native ploughs as can be done by a European plough, you require three of the former with three pairs of cattle and three drivers. The man who buys a European plough can readily procure the money needed by selling a pair of his cattle. It is true that he would frequently require for the European plough a larger and a better fed pair of cattle than those generally used, but then there is a still further saving when the plough is not in use in wages and cattle-keep in favour of the investment. It must also be remembered that there are many styles of improved ploughs which can be purchased for less than Rs. 20, as will be shown further on; but at the same time it must also be borne in mind that cheapness and low price do not mean the same thing, and on this point the following remarks may be quoted here; they are from the Farm Report for 1881:—

"It is worthy of record here that several of the iron ploughs supplied to the Farm more than twelve years ago, and which have been regularly worked, are still in good order. Of course the working parts have been replaced as necessity arose for this, and the ploughs have been always kept

* This saving is based on rates of cattle hire pertaining at Saidápet; of course elsewhere the actual saving might not be so great, but relatively it would be. In doing deeper work the saving would be greater still.

in good repair. They were made by Messrs. Ransome and Sims of Ipswich, and Messrs. Howard of Bedford. The great durability of the ploughs of these eminent manufacturers should be taken into account when the prices charged for their ploughs are being considered. The great aim now appears to be to procure for the ryot a plough at the lowest possible price, without reference to the efficiency or durability of the implement. It has been repeatedly pointed out in these reports that a low-priced plough is seldom a cheap implement in the long run. It is highly undesirable that ryots should be induced to purchase low-priced, badly-constructed ploughs, made of inferior material, with which to institute a better system of tillage; the disappointment that would naturally result would retard, rather than hasten, the general use of improved ploughs."

Another objection which is often raised to European ploughs is the distance of the driver from his cattle. This has some force, but very little, and regarding it the next quotation from the report for 1882 is given.

"Great difficulty has been met in experimenting on the Farm with single-handle ploughs made like the country plough. The Farm ploughmen have for years used only the double-handle ploughs of the European pattern, which require far less exertion on the part of the ploughman than country ploughs. The men most decidedly prefer the double-handle ploughs. A great deal of nonsense has been written regarding the supposed advantage of a single-handle plough in its admitting, when at work, of the ploughman using one of his hands in twisting the tails of his cattle. The Farm ploughmen plough a much larger area of land in a day than is usually ploughed elsewhere; yet, as has already been noticed, they work only double-handle ploughs and never touch the tails of their cattle; indeed, any such reprehensible performance as tail-twisting, though apparently, in some quarters deemed inseparable from ploughing with cattle, would lead to the immediate dismissal of the ploughman. Each ploughman uses a pair of reins, and carries on his plough a light whip, which he occasionally uses. Each man manages entirely his own plough and cattle; some of the men can make as straight a furrow as is made in other countries."

The ease with which the English plough can be made or repaired by native blacksmiths has been abundantly proved on the Farm, in the workshops attached to which ploughs of different descriptions have frequently been manufactured by men who, before they were taken into the shops, never saw a real plough. The castings so often used at home must of course be avoided, but that is easily done.

Although experience has clearly shown that in adopting the English plough the ryot will follow the course most beneficial to his own interests and to those of the country, experiments have been made to remove, by simple alterations, some of the greatest defects of construction in the native implement. The dead weight of the native plough is extraordinarily little, but its draught is enormous; on one occasion it was found that—

1. An ordinary native plough, the dead weight of which was only 32 pounds, needed a force of 390 pounds to drag it through the soil when working.
2. An ordinary native plough, with some slight improvements, the chief of which was the removal of the upright flat surface behind the share, by cutting down both sides, the dead weight of it then being 36½ pounds, required a force to drag it when working of 336 pounds.

3. An ordinary native plough, improved as in No. 2 experiment and fitted with a wooden mould-board, the dead weight being 56 pounds, required for dragging it when working a force of 280 pounds only.

In these experiments, all three ploughs were doing the same amount of work, viz., moving two cubic yards of earth in each hundred yards of furrow, and were all dragged in a uniform way by coolies. It will be observed that the improvements made materially lessened the draught; it is also worthy of notice that the heaviest plough did its work with an expenditure of nearly thirty per cent. less force than the plough which was only about half its weight. On working out the results on the plan given in the table below at page 52 the efficiency of the ploughs was No. 1, 722; No. 2, 630; No. 3, 519; or comparatively that of No. 1 to No. 3 was as 100 to 139, the latter being 39 per cent. more efficient as far as the draught was concerned.

In 1882 a number of improved country ploughs was made up at the request of a land-owner resident in Tanjore, who for the previous three or four years had employed a Graduate of the School of Agriculture as his manager. He forwarded a pattern plough, which he called the "Nawab," that he had obtained from Cawnpore, and of which he had been making up copies in Tanjore; but, finding the expense too great, he had given up further efforts in that direction. On receipt of the pattern at Saidápet, it was examined and tried and was found defective in several respects. An improved form of country plough was, therefore, made up and sent to the applicant for experimental trial along with his pattern plough. He wrote: "I have received the ploughs sent to me, and experimented with them in wet land, and find that the cattle here work with your light improved pattern with a greater amount of ease and facility than with the 'Nawab' plough, and at the same time this improved pattern inverts the furrow to the proper degree or position, whereas the other plough fails to do so." In explanation of a Madras land-owner sending all the way to Cawnpore for ploughs, it should be stated that he first applied to the Farm for ploughs, but that, the workshops then being closed through some misapprehension on the part of Government, no ploughs could be supplied from the Farm, and he had, therefore, no choice but to send to Cawnpore. This improved country plough weighs about 30 lb.; though a low-priced plough, it is not one that can be recommended for general use; it cannot, in full work, last longer than a ploughing season without repair, and it is always liable to break when the work it is required to do is at all rough in character. It is adapted only for use on wet land, or very light dry land, and is not suited for deep ploughing.

Another improved country plough, made entirely of iron except the pole, has proved fairly successful for irrigated land, and for working between the rows of cotton and in similar work on dry land. The stilt of this plough is fitted with a cross bar to admit of both of the ploughman's hands being used. These ploughs cost from Rs. 6 to 7 each. They are much stronger, and therefore more useful, than those with wooden stilts.

The following wood-cut shows the nature of this implement :—

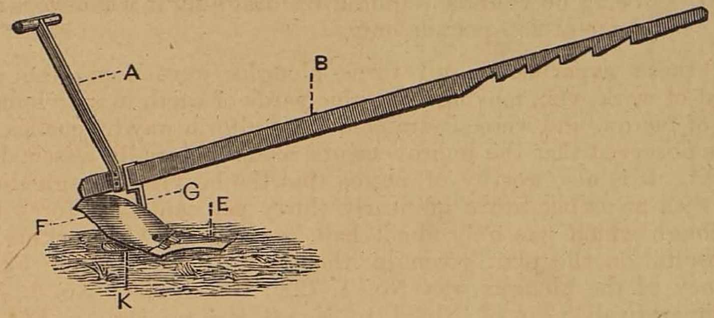

Fig. 4.

A—Stilt or handle.
B—Shaft or pole.
E—Share.
F—Mould-board.
G—Body.
K—Sole and landside.

This plough is at present in considerable demand, and is liked by the ryots as being something like their own implement. It cannot be expected to last long and no one can be particularly advised to purchase it in preference to the better made and more complete ploughs shown below. It has been suggested that the mould-board of this plough should be placed on the left-hand side instead of the right as shown, but the idea seems to be scarcely worth attention.

The next figure represents Ransome's primitive plough modified so as to suit South Indian conditions as far as possible. It is suitable for the same description of work as the improved country plough, it is as efficient as can be expected, simple in construction, and of low cost if made up in India. Ransome's price is Rs. 18, but it can be made in India for 8 or 9 rupees. The letters indicate the same parts as in Figure 4.

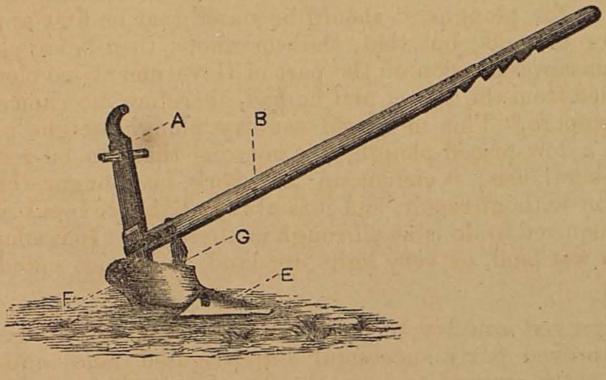

Fig. 5.

Recently Messrs. Massey and Co. of Madras have been turning out some small iron ploughs on the same general lines as those shown in the preceding diagrams, that is, with a fixed pole or shaft as in the

native plough. The pole in their ploughs is made of gas-piping and is therefore light, but it is questionable whether the arrangement of a fixed pole is a good one, for, though it meets a prejudice of the ryot, it involves a false position for the cattle in drawing the plough and places them at a disadvantage. These ploughs have been tried and can be said to be as efficient as can be expected in such a form. Massey's Indian-ryot's plough, and Avery's "Hindustan" plough are on much the same lines. The latter has the advantage of the working parts being of cast steel.

Allen's "Cast" plough, which is represented below, has certain defects, and it is only shown here as it was to a great extent the forerunner of and pattern on which a good many very useful ploughs have been constructed in India; amongst these is "Kaiser" plough made at Cawnpore, which appears to be a copy of this or of a closely allied plough, made up in inferior materials and with defective workmanship.

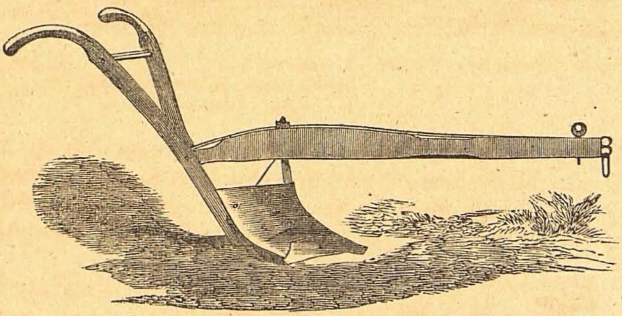

Fig. 6.

This, together with another plough, was obtained from America in 1875; it is a small cast-iron plough intended to be drawn by one horse or mule for use in cotton culture; the other, a steel plough differs only from it in having a steel mould-board with a polished cast-iron share and landside, and in the mould-board also being less abrupt. In both cases the beams and stilts are wooden, and the general construction is not good for ordinary work; the mould-boards are set nearly at right angles to the beam, thus making the draught very heavy; and the slades are so short that the ploughs move very unevenly through the soil, in places going so deeply that they become fixed; by placing a wheel under the beam the latter drawback has been avoided, and a slight alteration in the form of the mould-board greatly reduces the draught. The cast-iron working parts, also, are objectionable; they being very liable to be broken when in use by coming into contact with stones or the roots of trees. Implements that are fitted with working-parts made of cast-iron are not yet suited for general use in this country; much annoyance and loss have already been experienced from the purchase of such implements.

The next figure shows a modification of the last plough worked out and made up on the Saidápet Farm. It is made in two sizes;

the larger being suitable for general purposes and costing Rs. 13, the smaller being only adapted for use on light and irrigated land and costing Rs. 9. They are recommended for their simple construction and efficiency.

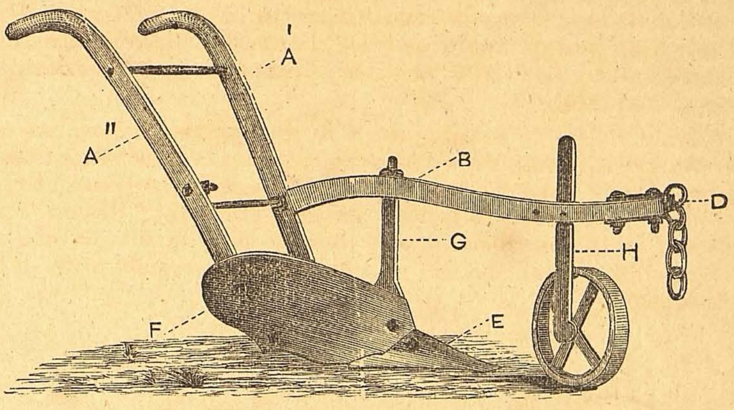

Fig. 7. Parts as in Fig. 4. B—Beam.
D—Bridle or hake and chain.
H—Wheel and standard.

The following wood-cut shows a small plough made up by Messrs. Ransome, Head and Jefferries, on suggestions as to the improvement of the "Kaiser" plough given by an officer connected with the Farm during a visit to their works. It is sold as the W.M.S. plough :—

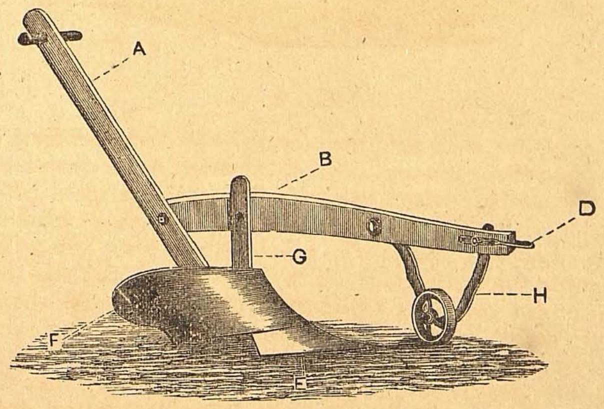

Fig. 8. Parts marked as in Fig. 7.

It is well made, and the cost delivered in Madras is Rs. 12-8-0 ; Messrs. Massey & Co. being the agents. The wearing parts are all of steel, and the plough, as will be seen in the table at page 54, works very well. It is well suited for small holdings, and could easily be altered so as to take a fixed shaft as in the plough at Fig. 4, if desired. The superiority of workmanship in the ploughs of these makers has already been referred to.

The next illustration shows Howard's pony plough D, a very useful

and strongly constructed implement for general purposes, which can be made up in this country for about Rs. 20.

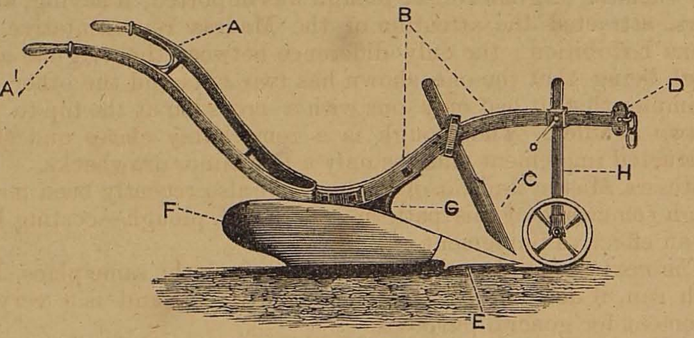

Fig. 9. Parts marked as before; C—Coulter.

Fig. 10 is Ransome's R.H.A. plough, and closely resembles the B.F.I. pattern of the same makers, which is used as a standard plough on the Farm. It can be made up for about Rs. 25 in India and is very useful for all ordinary work and also for ridging up land for such crops as maize, &c.

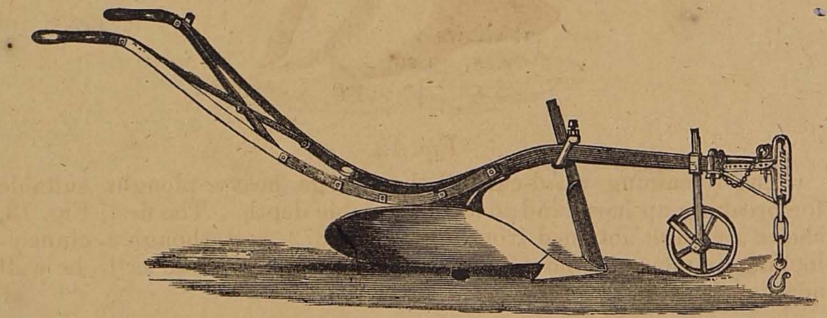

Fig. 10.

The next illustration shows a plough obtained from Överum's Bruk, Sweden, there issued under the number 29 B :—

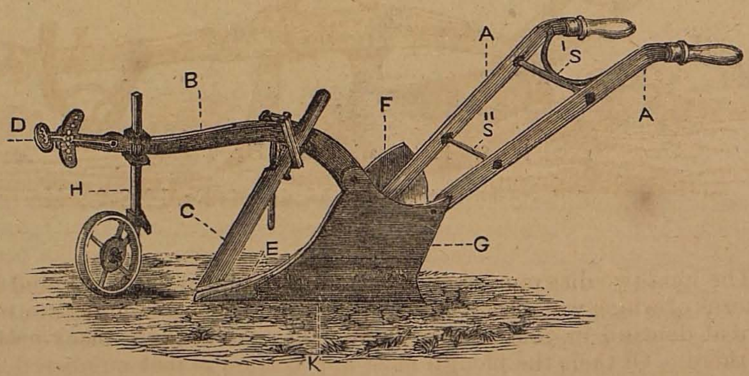

Fig. 11. Parts as in Figs. 4 and 7; C—Coulter; S′ and S″—Stays to stilts.

This is the plough which was recently selected for distribution by Government, and was brought to notice in a slightly different form in 1876 when the original No. 29 plough was imported, it having, amongst others, attracted the attention of the Madras representative at the Vienna Exhibition; the only difference between the original and this plough being that the one shown has two silts and the other was so far simpler that it had only one with a cross bar at the top to receive the two handles. The plough is a remarkably cheap and strongly constructed implement and has only a few minor drawbacks.

Messrs. Massey and Co. of Madras have also recently been making a plough somewhat of this pattern—their B.S. plough—costing Rs. 25; it is an effective implement.

The next figure shows another plough from the same place, No. 34, which can, if desired, be worked with a wheel, and is a very useful implement for general purposes.

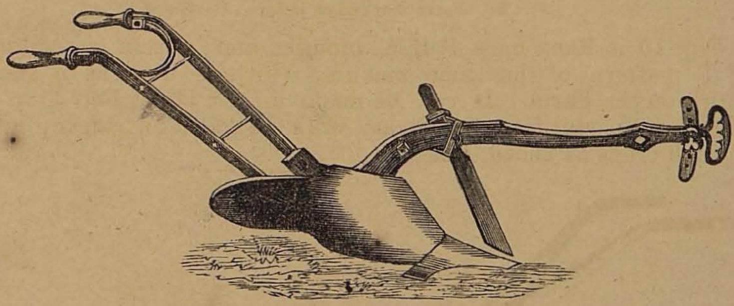

Fig. 12.

The remaining wood-cuts all show large heavy ploughs suitable for breaking up hard land to a considerable depth. The first, Fig. 13, shows a plough obtained from Boston in 1872, and, though a clumsy-looking implement, the various parts of it are so made as to be well adapted for rough work.

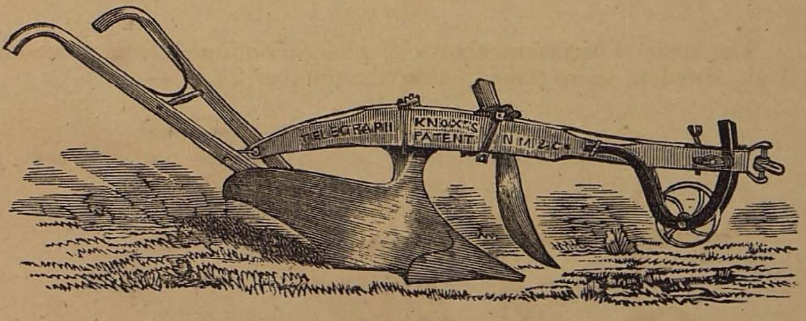

Fig. 13.

The next two diagrams show Överum's Bruk ploughs Nos. 9 and 16, patterns of which were first imported in 1877. These ploughs are now in great demand in the Bellary district for breaking up black-cotton soil there. Of them the plough most appreciated is that numbered 16, and is sold, after being strengthened, by Messrs. Sabapathy Moodelly

& Co. of Bellary for Rs. 65. These ploughs are said to be able to do in a day of six hours:—

		ACRE.
Ploughing land in a very dry state	... ...	½
Do. in a fair state	... ...	¾
Do. in very good state	... ...	1

The cost of working with them being Rs. 3 per acre as contrasted with the work of the large country plough at Rs. 8 per acre.

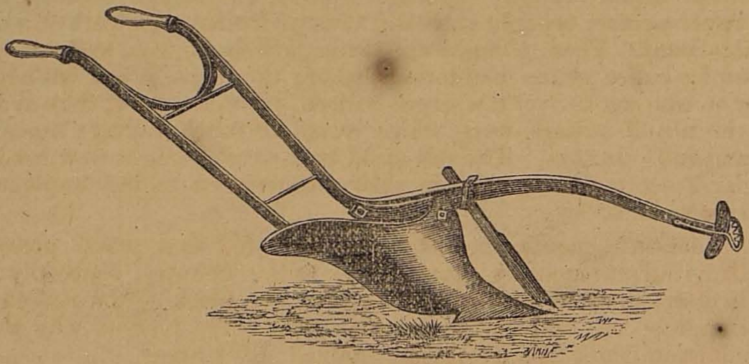

Fig. 14.

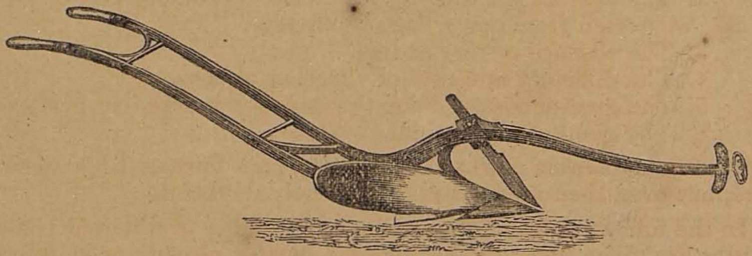

Fig. 15.

The next and last illustration of a plough shows Ransome's full sized Newcastle prize plough, which may be regarded as the type of a perfect implement after the English pattern. It is too heavy for general purposes in this country, but has been used on the Farm with good effect for special work, such as breaking up hard land. It is very easy to manage from having two wheels.

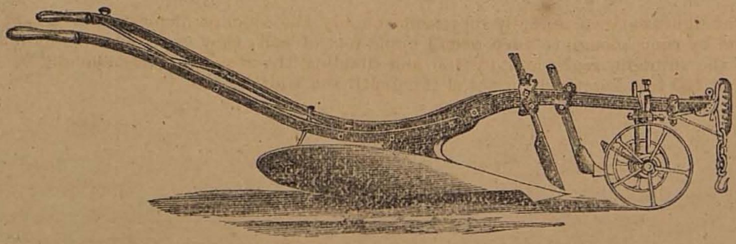

Fig. 16.

One of Ransome's turn-wrest pony ploughs has been in use; when employed for cultivating between the rows of cotton, maize, sorghum, &c., it performs its work in a satisfactory manner, and the draught is very low. Turn-wrest ploughs are specially intended for use on the slopes of hills, on which it is desirable to throw the furrow slice on one side only; for this purpose the mould-board is reversible; still they are well suited for use as ordinary ploughs on level land for cultivating, &c., and possess an advantage over ploughs of ordinary make, for when the mould-board is worn near the sole, it can be reversed and the upper portion brought into use, thus performing the part of a new mould-board. These ploughs are made entirely of iron, and are well suited for coffee or tea plantations, where the slope is not too great. They can be worked with a single bullock, pony, or mule, thus avoiding the use of swingle-trees, which would do much damage amongst tea and coffee bushes. The full-sized turn-wrest ploughs now used in England are much superior in their construction to the implement referred to here.

As not infrequently it has been suggested that steam ploughs might be advantageously introduced into this country, especially for use in districts where extensive level plains of black-cotton soil exist, it will not be out of place to summarise here the reasons why their introduction is not likely to be successful. They are—

1. The small holdings of the ryots.
2. The absence of roads by which the machinery can be transported from one village to another.
3. The absence or cost of fuel.
4. The difficulty and cost of effecting repairs.
5. The greater cost of doing the same work over that performed by good cattle ploughs.

Such an apparatus might be profitable on a farm of 1,000 acres or more, but even then its success is extremely doubtful.

In the following table, the results of a number of different trials of ploughs are given, most of the ploughs having already been referred to. The results obtained under different conditions cannot be fairly compared with one another unless reduced to comparison by one common standard; in many cases a common standard is shown, viz., the working of Ransome's B.F.I. plough. The figures given in the fifth column of each series show the comparative amount of force required by each plough in turning over the same amount of soil; the lower the figures,* therefore, the more efficient the plough.

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* The figures shown actually represent roughly the amount of force that would be required by each plough to turn over 1 cubic foot of soil; they were obtained by multiplying the draught registered by 100 and dividing the result by the amount of soil moved in 100 feet length of furrow of the depth and width noted.

Name of Plough.	Number of illustration.	Dead weight.	Cost.			1					2					3				
						Work done.			Draught.	Efficiency.	Work done.			Draught.	Efficiency.	Work done.			Draught.	Efficiency.
						Furrow.		Soil moved in 100 ft. run.			Furrow.		Soil moved in 100 ft. run.			Furrow.		Soil moved in 100 ft. run.		
						Depth.	Width.				Depth.	Width.				Depth.	Width.			
						1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
		LB.	RS.	A.	P.	IN.	IN.	C.FT.	LB.		IN.	IN.	C.FT.	LB.		IN.	IN.	C.FT.	LB.	
Ransome's B.F.I. & R.H.A. ...	10	92	48	0	0	5	9	31·25	280	896	3·75	9	23·4	175	748	7·8	11·5	62·1	358	576
Howard's D.	9	86	36	0	0	7	8	38·9	330	848	...	...	...	...	...	...	...	...	...	...
Ransome's K.W.S.	...	58	16	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Överum's Bruk No. 29	...	82	18	0	0	...	...	...	...	...	4·5	11·50	35·9	273	760	...	...	...	...	...
Do. do. No. 29A	...	88		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 29B	11	88	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 34	12	90	27	8	0	...	...	...	...	...	4·	10	27·8	231	831	...	...	...	...	...
Do. do. No. 39	...	137		...		...	...	...	...	...	4·5	11·9	37·2	273	734	...	...	...	...	...
Do. do. No. 40	14	137	31	8	0	...	...	...	...	...	4·56	11	34·8	273	784	...	...	...	...	...
Ransome's W.S.R.A.W.	...	53	18	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Boston	13	90	45	0	0	6	11	45·8	330	720	...	...	...	...	...	...	...	...	...	...
Collins' with Coulter	...	60		...		...	...	...	...	...	...	...	...	...	...	7·8	10·3	55·8	336	602
Do. without Coulter	...	57		...		...	...	...	...	...	...	...	...	...	...	8	10	55·6	308	554
Do. No. 106 J.F.	...	...		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. No. 107 J.F.	...	...		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Allen's Steel	...	45	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. Cast	6	34	10	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. improved at Saidápet.	7	56	13	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cawnpore "Kaiser"	...	34	5	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ransome's W.M.S.	8	28	12	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Massey's C.S.	...	...	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Name of Ploughs.	Number of illustration.	Dead weight.	Cost.			4 Work done. Furrow. Depth. 1	4 Work done. Furrow. Width. 2	4 Work done. Soil moved in 100 ft. run. 3	4 Draught. 4	4 Efficiency. 5	5 Work done. Furrow. Depth. 1	5 Work done. Furrow. Width. 2	5 Work done. Soil moved in 100 ft. run. 3	5 Draught. 4	5 Efficiency. 5	6 Work done. Furrow. Depth. 1	6 Work done. Furrow. Width. 2	6 Work done. Soil moved in 100 ft. run. 3	6 Draught. 4	6 Efficiency. 5
		LB.	RS.	A.	P.	IN.	IN.	C.FT.	LB.		IN.	IN.	C.FT.	LB.		IN.	IN.	C.FT.	LB.	
Ransome's B.F.I. & R.H.A. ...	10	92	48	0	0	...	...	...	...	...	4·8	10	33·3	196	588	3·6	10·3	25·75	277	1,076
Howard's D.	9	86	36	0	0	...	...	...	...	...	4·8	10·6	35·3	224	634	...	...	...	...	...
Ransome's K.W.S.	...	58	16	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Överum's Bruk No. 29	...	82	18	0	0	...	...	...	...	...	4·8	11·6	38·7	238	616	...	...	...	...	...
Do. do. No. 29A	...	88		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 29B	11	88	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 34	12	90	27	8	0	...	...	...	...	...	5·2	9	32·5	193	594	...	...	...	...	...
Do. do. No. 39	...	137		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 40	14	137	31	8	0	5	9	31·25	246	787	...	...	...	...	...	...	...	...	...	...
Ransome's W.S.R.A.W.	...	53	18	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Boston	13	90	45	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Collins' with Coulter	...	60		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. without Coulter	...	57		...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. No. 106 J.F.	...	...		...		8	10·6	58·9	420	713	...	...	...	...	...	...	...	...	...	...
Do. No. 107 J.F.	...	...		...		7·4	10	51·4	566	1,103	...	...	...	...	...	...	...	...	...	...
Allen's Steel	...	45	18	0	0	...	...	...	...	...	4·6	6·8	21·7	210	967	...	...	...	...	...
Do. Cast	6	34	10	0	0	...	...	...	...	...	6	10·2	42·5	585	1,376	3·6	8·5	21·15	289	1,366
Do. do. improved at Saidápet.	7	56	13	0	0	...	...	...	...	...	...	...	...	...	...	4·5	9·6	30	271	903
Cawnpore "Kaiser"	...	34	5	8	0	...	...	...	..	...	...	...	...	...	...	4·4	6·75	20·6	228	1,109
Ransome's W.M.S.	8	28	12	8	0	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...
Massey's C.S.	...	...	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Name of Ploughs.	Number of illustration.	Dead weight.	Cost.			7					8					9				
						Work done.					Work done.					Work done.				
						Furrow.		Soil moved in 100 ft. run.	Draught.	Efficiency.	Furrow.		Soil moved in 100 ft. run.	Draught.	Efficiency.	Furrow.		Soil moved in 100 ft. run.	Draught.	Efficiency.
						Depth.	Width.				Depth.	Width.				Depth.	Width.			
						1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
		LB.	RS.	A.	P.	IN.	IN.	C.FT.	LB.		IN.	IN.	C.FT.	LB.		IN.	IN.	C.FT.	LB.	
Ransome's B.F.I. & R.H.A. ...	10	92	48	0	0	5·6	9·25	35·9	196	546	$5\frac{1}{4}$	11	40·1	280	698	6	10	41·6	336	800
Howard's D.	9	86	36	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ransome's K.W.S.	...	58	16	8	0	6·33	9	39·56	289	730	$4\frac{2}{3}$	$9\frac{1}{2}$	30·8	244	796	$5\frac{1}{4}$	8	29·2	280	959
Överum's Bruk No. 29	...	82	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 29A	...	88	...			...	...	...	...	...	$3\frac{3}{4}$	10	26	244	939	$5\frac{1}{2}$	9	34·4	308	895
Do. do. No. 29B	11	88	18	0	0	5·5	9·6	36·6	172	478	$4\frac{1}{2}$	9	28·75	202	703	6	$10\frac{1}{4}$	42·7	448	1,049
Do. do. No. 34	12	90	27	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 39	...	137	...			...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. No. 40	14	137	31	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ransome's W.S.R.A.W.	...	53	18	8	0	7·75	11·25	60·55	392	647	5	$10\frac{1}{2}$	36·5	196	537	6	$10\frac{1}{4}$	42·7	280	656
Boston	13	90	45	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Collins' with Coulter	...	60	...			...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. without Coulter	...	57	...			...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. No. 106 J.F.	...	...	...			...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. No. 107 J.F.	...	...	...			...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Allen's Steel	...	45	18	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. Cast	6	34	10	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Do. do. improved at Saidápet.	7	56	13	0	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cawnpore "Kaiser"	...	34	5	8	0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ransome's W.M.S.	8	28	12	8	0	4·7	6·6	21·5	145	674	4	8	22·2	168	756	...	...	...	...	...
Massey's C.S.	...	...	18	0	0	...	...	...	...	...	$5\frac{1}{2}$	10	38·2	308	806	$5\frac{1}{2}$	9	34·4	280	811

The following notes may be of use in elucidating the figures in the table. The dead weight of ploughs has little influence on their efficiency as cultivating implements and the draught required in using them, nor does it affect their portability much if they are supplied with a wheel or placed on a sledge. The prime cost of a plough also should not be considered too closely; superiority of construction often far more than compensating for a slightly higher price. In the prices given, the rates quoted are those at which the ploughs have been obtained for the Farm and delivered in Madras. The first nine ploughs on the list are wholly made of iron and therefore far more durable than the others, into the construction of which wood enters more or less. Of all these ploughs the following can be specially recommended for the work named:—

Heavy work or for stiff soils.	Boston plough. Ransome's W.S.R.A W. Överum's Nos. 39 and 40.
Ordinary work on medium soils.	Ransome's B.F.I. and K.W.S. Howard's D. Överum's Nos. 29 and 34.
Work on light soils or with weak cattle.	Allen's, improved at Saidápet. Ransome's W.M.S.

Reference should also be made to the remarks accompanying the illustrations already given.

The first group of results was obtained at some trials made in 1872 with the object of testing the Boston plough in comparison with those then in general use. It will be noticed that they are favourable to that plough, although it is a far more clumsy implement.

Series No 2 was obtained in 1877 during the trial of a large number of patterns received (from Sweden) from the Secretary of State; they were received as swing ploughs, but even when fitted with a wheel were not found on trial to be quite so efficient as those of English make, but still, being much cheaper and of a stronger build, several of them have a good deal to recommend them for introduction into this country. Patterns Nos. 39 and 40 can be recommended for rather heavy work. Patterns Nos. 34 and 29 are very useful general-purpose ploughs; 29 is peculiar in having only one stilt, and it gave results but very little inferior to Ransome's plough, whilst its cost in Madras is much less; it is well adapted for use on the prevalent light and medium soils of Southern India where cattle of sufficient power are available.

The results in group 3 were obtained in 1878 with two ploughs by Messrs. Collins of Hartford, U.S., which had been sent by them to the Farm during the year for trial. Both were swing ploughs; one was fitted with a revolving coulter; the second had no coulter at all. The ploughs were tested in a field, the soil of which is a friable sandy loam, but intermingled with pieces of bricks, it having been a tile-yard previously. The plough fitted with a coulter worked very steadily, the coulter acting as a wheel; at first, when the coulter was lowered and its edge fixed close to the share, pieces of bricks, which forced themselves between the share and coulter, not only stopped the turning of

the coulter, but also impeded the action of the share and increased the draught; however, on raising the coulter a little, the plough worked very smoothly. The second plough, without a coulter, did not work satisfactorily; the driver had great difficulty in managing it, as he could not keep it steady, the plough having a great tendency to go downwards, a defect which could be remedied by fitting it with a wheel.

The results in groups 4 and 5 were obtained at the same time and are those of the working of the usual standard plough, Ransomes' B.F.I., together with that of a number of other ploughs in common use on the Farm. They are separated according to the nature of the work done in either case. Regarding these results, it was remarked at the time—

"The trials were conducted in 1879 at the southern end of field No. 29; the soil is a sandy loam and was in a very favorable state for ploughing at that time, so that the conditions were rather more advantageous to English ploughs than the Swedish. If the soil had been drier, the good qualities of the Swedish ploughs would have been more clearly shown. At the same time the two Allen's ploughs imported in 1875 were tested, but the results obtained are not at all conclusive, as the ploughman using them at the time was unaccustomed to their use.

"It will be noticed that Ransome's plough heads the list. The only objection to this plough is that the stilts are so long that the ploughman is too far from his cattle, but this is in a measure counterbalanced by the greater control he has over the implement. The Swedish plough No. 34 is a very useful implement and one of the best we have; it is, taking into consideration the superiority of its make, the best referred to in the statement. The single stilted plough is a very effective and handy implement. Plough No. 40 is one better adapted for use on hard or stiff soils than on soil in the condition that that in which these trials were made was. Both the Collins' ploughs were difficult to manage; both had a tendency to go downwards, and the plough marked No. 107 (I.F.) especially so. This being the case, the driver was unable to keep them steady and could not make a straight furrow. Although both ploughs are nearly alike, yet one required much greater draught than the other. On examining this plough it was found that the share pointed about one inch more to the landside than in the other, which most probably caused the greater draught. The ploughs are made of excellent material, but I am afraid that they cannot well be used in this country unless modified and supplied with a wheel, the draught required being too great for country cattle, and the cultivators of this country not being skilled enough to work with the ploughs in their present state."

Regarding the seventh group, the following remarks were made in the report for 1880-81:—

"On the 18th December some experiments were made in field No. 27 with the undermentioned ploughs, with the results recorded.

"Ransome's plough is the usual standard plough employed at the Farm during plough trials. It is a wheel plough, made entirely of iron, and has been referred to in previous reports. The American plough was introduced on the Farm about seven years ago; it also has been noticed in previous reports. This plough is made of wood, and its working parts are of cast-iron. The great fault in the plough is the abruptness of the mould-board, which, unless the soil is very free and open, causes the draught to be heavy. The weight of this plough is about 34 lb. Delivered in Madras it cost Rs. 10, but it has since been fitted with a wheel at an additional cost of Rs.

1-12-0. The third plough referred to in the table is a copy of the American plough with some improvements. The price of the plough made up at Saidápet was Rs. 13; without a wheel the cost would be Rs. 11½, but the plough does not work well as a "swing" plough. The weight of this plough is about 56 lb. The Cawnpore plough, to test which the trials were specially made, was received from the Cawnpore farm, North-West Provinces, last year; it is made of wood, and has iron working parts; it also is a copy of the American plough just noticed, but has nothing to recommend it. It is certainly light and low-priced, but then the rude native plough may claim to possess these recommendations. The weight of the plough is 34 lb. and the price at Cawnpore was Rs. 5½. The plough is roughly finished, is without a wheel, and is unfitted to undergo the treatment ploughs usually receive in the field, while it does not turn over the furrow slice efficiently from the bad form of the mould-board. The soil of the field where the ploughs were tried was, on the occasion of the trial, loose and friable excepting in a few places, but the ploughs were all tried under similar conditions."

The results given in the last three groups of the table were obtained in 1882 and 1883. The three ploughs of Ransome's had been sent out for trial in the presidency by that firm on their own motion. The first of the three trials was carried out under favourable ploughing conditions, but, unfortunately, plough K.W.S. was tried without a wheel, with which it should have been supplied, and, as far as it is concerned, the trials were vitiated thereby. The plough W.M.S. turned a first-rate furrow, but the draught was too great for the work done. The plough W.S.R.A.W. cut a good furrow, but the draught was too heavy. In this trial, however, a comparison could scarcely be fairly made owing to the differences in the depth, etc., of the work done.

The results in the other two groups of figures were more recently obtained, in one of which a depth of work of five inches was aimed at, in the other six. The results were more favourable and conclusive, but are not decisive. The eighth series was obtained under favourable conditions, and the last, on a piece of stiffish soil in a bad state for ploughing, which caused great unevenness in the work done and draught required. The O.B. ploughs Nos. 29 A and B did not do well in either case. Massey's C.S. plough cut a very clean furrow, but did not place the slice well. Ransome's K.W.S. worked much better than in the first trial, but it had been fitted with a wheel, and the W.S.R.A.W. of the same makers showed itself very well suited for the work; whilst the W.M.S., only tried in one case, did very well in turning out comparatively shallow work.

The Grubber—otherwise called a Scarifier, or more frequently and erroneously a Cultivator, to some extent resembles the native plough in its action, but in nothing else, and is a very valuable implement to the farmer, especially on light land. It is indeed doubtful whether for naturally open soils it would not be better policy for the farmer to use a scarifier in general, leaving his ploughs alone, excepting for the occasional and most necessary process of deep cultivation: when once in a season the land has been ploughed and stirred to the full depth intended, probably, unless the soil, like that of the Farm, has the bad character of running together—setting on the surface with the first fall of rain—it would be advantageous to use a grubber only. For this purpose it might be said that the native plough is adapted;

but that is a mistake, for it is one of the most inefficient scarifiers imaginable, and even after it has crossed and recrossed a field three or four times, parts are still left untouched and unstirred, whilst with a good grubber, one, or, at the utmost on dirty or hard land, two turns will suffice. A good grubber, which can be worked by two pairs of moderate sized cattle, will go over in a day as much ground as three ploughs of the English pattern; whilst it would probably take from seven to twelve pairs of cattle with native ploughs, and an equal number of drivers, to do the same work with less efficiency.

The following figure shows a good general purpose grubber such as can be made up in India for about Rs. 35.

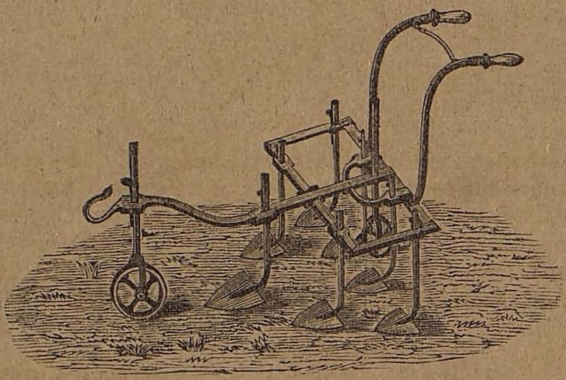


Fig. 17.

In 1882 a new implement was constructed which promises to be useful. It is a copy of one used largely in Germany. It consists of a strong iron beam which has holes for the reception of tines fitted with shares; these are broad and narrow for broad sharing, grubbing, or sub-soiling; and one of them can be fitted with a mould-board, so that the implement may be used as a cultivator, a grubber, a sub-soiler, or as a plough. Attention is being given to this implement in view to its further improvement and adaptation to the wants of this country. It has already proved a very useful one for stirring the soil deeply, and in sub-soiling is most efficient as it will stir a moderately free soil to a depth of 15-16 inches, a greater depth than can be reached by any other implement on the Farm. It is strong, simple in construction, and moderate in cost.

Harrows.—Various descriptions of these most useful implements have been used constantly in cleaning and preparing the land for sowing. Iron chain harrows either imported or made on the spot have been found to be of great value on the light sandy soils of the Farm in collecting weeds, covering seeds, and consolidating the soil, but they are expensive and cannot be made locally for much under Rs. 50. Iron prong harrows, either drag or seed harrows, or Ransome's jointed harrows, have been constantly used, but have not been found so generally useful as wood and iron harrows, besides being much too costly for this country.

A very useful description of harrow is shown in the figure below, which is very simple in construction, effective, and cheap.

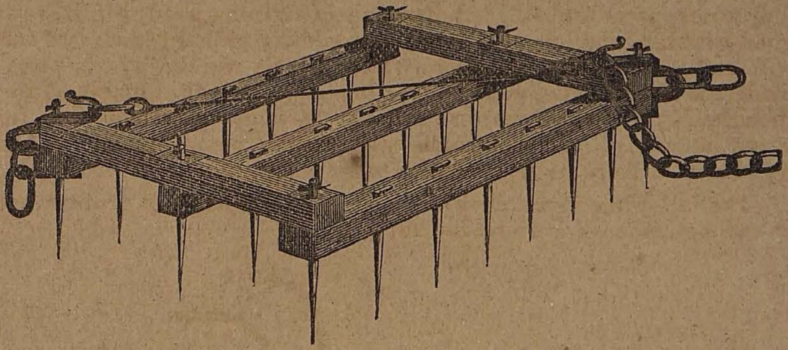


Fig. 18.

Rollers—are very useful implements, especially to the light land farmer, for consolidating the soil either before or after sowing the seed; they may also sometimes be used in conjunction with the harrow in breaking down clods, if time presses and the weather is not such as will lead the farmer to expect that they will be reduced by natural agencies. The following illustration shows a roller that has long been in use on the Farm.

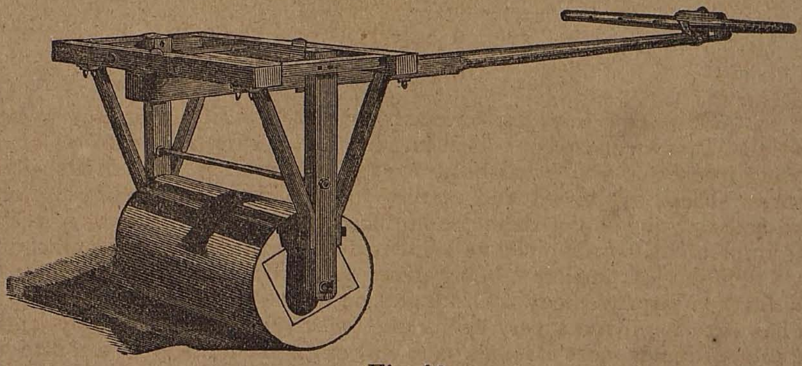


Fig. 19.

The next illustration from the *American Agriculturist* shows a very simple roller and is given together with instructions as to its manufacture:—

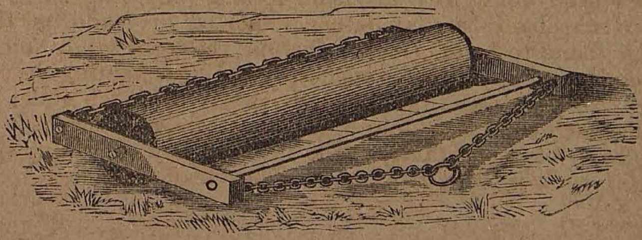


Fig. 20.

Take a log 6 or 8 feet long, 18 or 20 inches in diameter, and put pins in each end for journals, either of wood 1½ inches or iron 1 inch. Make a frame of 2″ by 4″ scantlings or flat rails 3 or 4 feet long, to suit the size of the roller. Bore holes for journals a little back of centre, and also inch. holes 2 inches from the back end of scantlings. Fasten these ends together with a chain or rope tight enough to keep the scantlings square with the ends of the log. Fasten the front ends together with a stiff pole or rail, and put a heavy chain across the front, with one end around each front corner. Attach the yoke pole at the middle of this chain. The draft chain and the pole will keep the front ends of the frame in position, and the chain behind will prevent the rear ends from spreading. When the roller goes faster than the team, the draft chain will slacken, and the front of the frame will drop and prevent the roller from striking the cattle.

Seed-Drills.—A thirteen-row drill of Garret's pattern is in constant use, and has proved of much value; nearly all our crops are now sown with it, and the work is done efficiently, cheaply, and quickly. The cost of working this drill per diem is about—

	RS.	A.	P.
One pair of cattle and driver...	0	12	0
One man steering	0	3	0
One man attending to seed	0	3	0
Oil	0	1	0
Interest on capital, wear and tear, &c., at 15 per cent. per annum on Rs. 300, charged on 60 working days	0	12	0
Total cost per diem ... Rs.	1	15	0

The machine sows about five acres a day, so that the cost of sowing is only 6 annas 2 pies per acre, a very moderate charge. The advantages of drilling seed over broad-casting are very well known, and for large holdings such a drill can be recommended.

On small holdings, however, a description of drill such as one constructed out of an old broad-cast seed-barrow is better adapted; it is fitted inside the hopper with rotary brushes fixed on an axle driven from the wheel; these throw the grain into the seed coulters, which are composed of loose tin funnels fitted into each other, as in the Garret's drill. The barrow has two seed coulters, but three can be used if necessary. The seed coulters can be regulated at pleasure to sow in lines from nine up to twenty-four inches apart, and, by altering the gearing, the speed of the elevating brushes can be increased or decreased so as to sow a large or small quantity of seed. This drill will sow all the usual grains and pulses—raggi, cholum, tennay, shamay, varagoo, gingelly, cumboo, the grams, &c. With it three men on such soils as ours can easily sow about two acres a day. Drills of this sort can be made for Rs. 30 each—a moderate price when it is considered what sort of work they can perform.

In 1883, a small seed-drill was imported from England. It was made by Messrs. F. Bird and Company, London, and cost at their works £5-0-0, and delivered in Madras, Rs. 77. It is made to sow two lines of crop at varying distances at pleasure. It can be worked easily by two coolies; one pulling and one guiding the machine. It will sow seed at different rates per acre according to the speed of the seed-cups. The depth at which the seed is deposited can also be

regulated. When being worked it gets over more ground than the ordinary three-rowed bamboo drill, and is much cheaper to work. This drill was purchased as it was thought that it might be suggestive of some means of improving the bamboo drill. It is a much better machine than the barrow drill.

Ordinary country bamboo drills may be turned out at a cost of not more than one-tenth of that of the last drill, but the work performed by them is very indifferent; besides, where a number of different crops are grown, requiring to be sown in lines at varying distances apart, a separate drill is required for each, the seed coulters being fixed only to sow at one width; again the bamboo drill does not sow at a regular depth, and the quantity of seed it sows per acre altogether depends on the skill or watchfulness of the man who attends it. There is no guarantee of regularity. The sower may sow one part of a field at the rate of 50 lb. per acre, another part at 30 lb., and on other parts he may altogether omit to sow any seed. It is quite true that many ryots do excellent work with these very primitive implements; but then the ryot himself drops the seed into the seed hopper; he is not generally dependent on hired laborers, whose interest in the work is confined to getting over the land as speedily as possible.

It is a serious matter to have land badly seeded, as the defect cannot be discovered until the crop appears above ground, when, owing to many circumstances unnecessary to detail here, it is frequently impossible to remedy matters; the only choice being either to plough and sow again, or to leave the crop with large blanks, in which weeds will grow and give endless trouble. There can be no doubt but that, on any holding on which 30 acres of dry crop are sown annually, the cost of a good seed drill will be more than repaid during each year in which it is used; not large complicated drills, such as are used in England and other countries, and mentioned above as suitable for large holdings where labor is costly, but such drills as can be made at from 25 to 30 rupees each. There is a class of superficial reasoners always ready to oppose the introduction of any improved implements or machines, if only these machines are more costly than those already used by the ryot, altogether regardless of their superior efficiency over those in use. To such it may be said, what every thinking man must at once admit, that if a drill, costing 30 rupees, will in a year return on thirty acres of crop one rupee per acre in excess of the amount a similar area of crop sown by the ordinary drill would yield, it must be to the ryot a much more desirable machine to possess than the one he already owns, though this may have cost him only one-tenth of the sum that he would pay for an improved drill.

The economy in the amount of seed required in drill-sowing is very great, amounting sometimes to five-sixths of that which is ordinarily used; especially is this the case with small seeds, such as raggi or indigo. To admit of interculture during the growth of the crop, drill-sowing is requisite, and of the value of after-cultivation there is no doubt, loosening and cleaning the surface soil as it does.

Hoes.—Associated with drill-husbandry is the use of the *bullock* or *horse hoe,* otherwise called a *cultivator.* These implements, which are made for the purpose of stirring the soil between the rows of any

crop, when working cut off and destroy many weeds, thus lightening the labor of hand weeding or hoeing; there are indeed few more useful implements to the Indian cultivator, especially when irrigation between the rows of standing crops is adopted. After watering, the soil usually becomes caked on the surface, and if water is again applied when the land is in that state, it either runs off or evaporates. When the cultivator is passed between the drills shortly after the surface soil has begun to cake, it pulverises and opens up the soil, enabling it to absorb the dew and the water when it is next applied. In some districts where the bamboo drill is in use a small bullock hoe (*danthi* or *pápatam*) is to be found; it is a dangerous implement to use owing to the difficulty of managing it and the liability that exists for its cutting off a considerable number of plants in its erratic course.

The following wood-cut shows a pattern of bullock-hoe made by Messrs. Ransome, costing 30—40 rupees, which is a very useful implement, remarkable for simplicity of construction and the efficiency of work it performs.

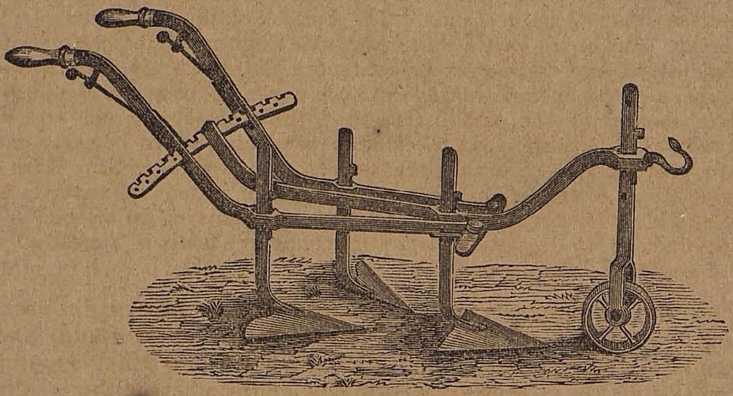


Fig. 21.

Besides bullock-hoes, a few *wheel-hoes* for manual power, have been made and used, but the general results have not been very encouraging. They were made both with pronged and broad tines; but neither did the work as well as ordinary hand-hoes, while they cannot be worked as cheaply as those drawn by cattle. One or two have been supplied to tea plantations; for hoeing on the slopes of hills they are probably well suited, it being a work in which they have not to compete with cattle hoes, while in forcing the hoe down or obliquely across a slope, it can be pushed with much greater force than over level surfaces.

Many varieties of *hand-hoes* have been tried, but it has been found best to use a heavy one like that used by coffee planters; in the dry season especially they can be used at times when light broad hoes, like those used for turnip culture in England, fail to penetrate the ground, and then of course the advantages of using hoes are especially great in killing weeds and increasing the absorptive powers of the soil. *Hoe-forks*, that is pronged hoes, have been found of use in digging over loose moist ground three or four inches deep, as

for instance in a plantain garden, where cattle power cannot be made use of.

WATER-LIFTS.—The extension of cultivation under wells is admitted by all to be greatly desired in Southern India; for not only does this branch of husbandry enable crops to be grown during the dry weather or in droughty seasons, but it is also the one practice in native farming to which most care and intelligence is devoted. On lands which are watered thus the ryot uses most of the little manure he ever applies on his farm, and in all respects the agriculture of the "well" irrigated lands is of a higher type than any other practised by him. The invention, application, or introduction of economical water-lifts is therefore a work of great importance.

The *Single Mhote*, or inclined plane lift, is well known throughout India. It has been described as follows :—

"The water is lifted from the well in a skin bucket, to the bucket is attached a rope which is fastened to the yoke of a pair of cattle; a roller or pulley is fixed about 4 or 5 feet higher than the discharging trough projecting slightly over the well, over this roller, or pulley, the rope travels as the bucket ascends or descends. The bullock path is an incline. When raising the bucket the cattle walk down the slope until the bucket reaches the full height and discharges its contents; the cattle are then backed up the slope, and the bucket sinking into the water, to be again raised by the forward motion of the cattle, and thus the process is again and again repeated. This arrangement is certainly very simple, it is however equally certain that the cost of raising the water by it is very great. With this machine a pair of cattle while raising only 6,900 gallons of water in a day are exceedingly hard worked in doing it; whilst backing up an incline with a slope of about 45 degrees, about forty times per hour, is a most effective way of rendering cattle worthless."

The *Double Mhote*, is an adaptation of the whim or gin used for raising water and rubbish from mine shafts in England, and in Australia for raising water for the stock, &c. It is much superior to and will probably in time supersede the single mhote, although doubtless the prejudice, poverty, and habits of Indian ryots will perhaps retard for a long time its general adoption. The first machine was erected in 1869, the driving part being copied from a model brought to this country from Australia by Mr. E. G. R. Fane, formerly Collector of Chingleput; the rope arrangement and buckets were copied from a sketch, which was supplied to the then Farm Committee by the Rajah of Venkatagiri. Since that time the machine has been much improved, and, as it now exists on the Farm, its mode of action has been described as follows :—

"The water is raised by two leather buckets, similar to those in ordinary use in most parts of this presidency; to each of these buckets is attached a rope which is fastened to a drum; one of these is coiled and the other uncoiled as one bucket ascends and the other descends; the drum is fixed on a rotating spindle, to which is fixed at right angles the draught bar to which the bullock is attached; the diameter and thickness of the drum varies with the depth of the well; as a general rule, for all ordinary lifts the diameter of the drum may be equal to about one-fifth the number of feet that the water must be raised; the drum is placed about six feet above the ground in order to allow the rope to pass over the head of the draught bullock; the spindle upon which the drum is placed is kept in its

upright position by means of two beams, into which it is fixed, which cross each other at the middle, and are supported at the ends on posts placed opposite each other on the outer side of the bullock path. The bullock walks under the draught bar attached to a curved yoke, which turns on a swivel. In raising water the bullock travels round the upright spindle, thus turning the drum and winding one rope and unwinding the other. If the diameter of the drum is as suggested, $1\frac{1}{2}$ circuits around the path will raise each bucket to the requisite height; the bullock is turned round, facing the opposite direction, while each bucket is being discharged; no longer time is required to do this than is needed for the bucket to discharge its contents."

A plan and section of this machine, as seen working on the Farm, are shown opposite.

Comparing the two machines, it may be said that the "double" will raise in a given time about 30 per cent. more water than the "single mhote," whilst the saving of cost in lifting a given quantity is about 50 per cent. One bullock is enabled to do the work of two, although he must be a stronger one, and probably more costly than the pair which suffices for the single mhote; the economy in number will not be of much weight where inferior cattle are, as is commonly the case, numerous and cheap. The erection of the single mhote is within the means of almost every ryot, and the whole apparatus can be repaired with his own hands; whilst the double machine involves the outlay of a large sum of money and can only be repaired by a carpenter if it gets out of order. The objection which exists in backing cattle up a slope of about 1 in 4 or 5 can easily be overcome by adopting a practice, common in some places, of using two pairs of bullocks; allowing one to walk up alongside the track whilst the other is descending. The single mhote cannot be recommended except when used, as just stated, for high lifts, but it is likely to hold its own for many years.

Regarding the double mhote, an ingenious arrangement was adopted on the Bangalore Experimental Farm whereby a pair of bullocks can be used for this machine; Mr. Harman, the Superintendent, thus described his improvements on the pattern in use at Saidápet, from which he took his original idea :—

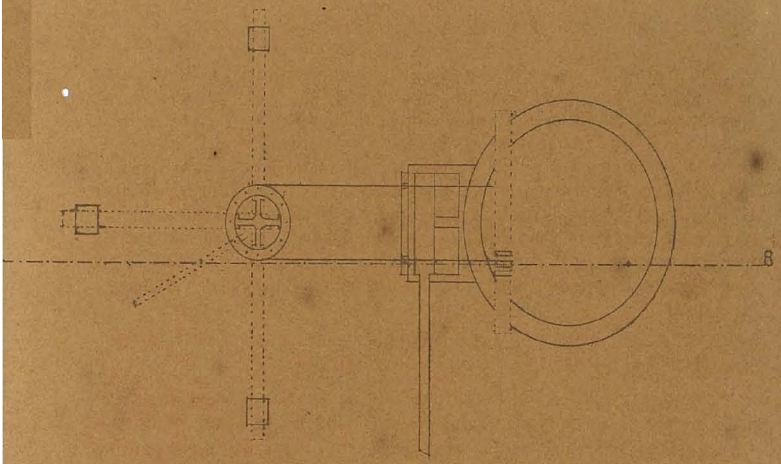
"The chief modification introduced is a wheel fixed by a vertical bar from the end of the beam to which the cattle are attached to equalize the balance, lighten the draft, and allow of a longer beam being used. The cattle can thus walk rapidly without turning giddy. The method of fastening the yoke for a pair of bullocks is employed, as bullock labor is plentiful on the farm."

The *Picotta*, or simple lever lift common to all oriental countries, works very well and cheaply for lifts of less than 12 feet; above that height it becomes expensive. A much better form of lift is used at Bangalore than that common in this neighbourhood.

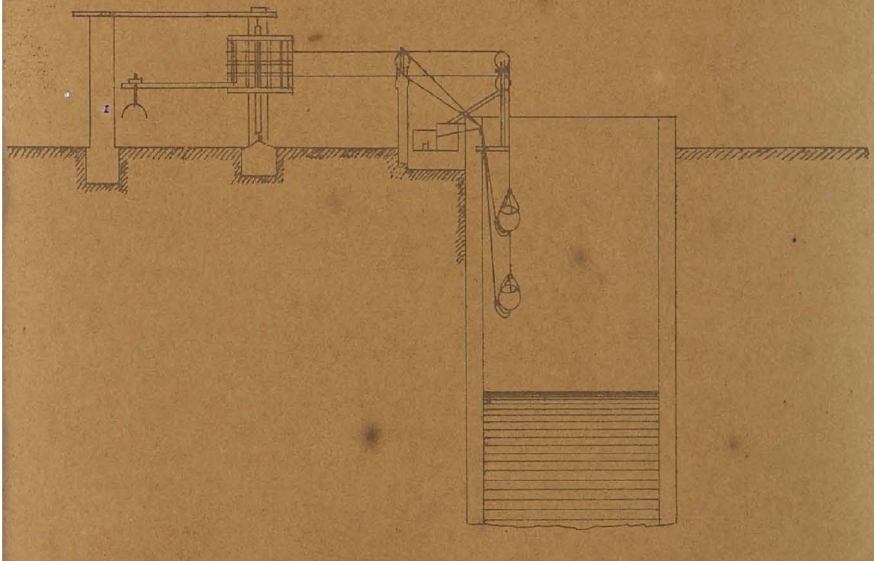
The *Bale* is suitable for low lifts of from 1 to 2 feet. This mode of raising water is simple and cheap. In the same position, the *Archimedian Screw* can be used.

Bucket Pumps, for cattle power, are costly and not very effective machines; the wear and tear on them is great, and their prime cost places them beyond the means of ordinary ryots.

PLAN.



SECTION THRO' A.B



Scale 12 feet to an Inch.

GOVT. LITHC. PRESS CHEPAUK.

TRANSFER BY P. SINGARAVALOO CHETTY.

LITHC. BY R. J. DALBREY GOVT. LITHC. PRESS

A Chain Pump for cattle power has been made use of several times. It was found to constantly require repair, irregular driving causing frequent breakages. The speed obtainable with cattle is not sufficient to work this machine well.

In the following table data are given regarding the capacity and cost of working most of the above mentioned machines.

Description of machine.	Height of lift.	Raised per hour.	Required to water one acre of ground one inch deep.	Men required.	Cattle required.	Cost of machine and of its erection.		
	FT.	C.FT.	HOURS.	NO.	NO.	RS.	A.	P.
Double Mhote	20	384	9·45	1	1	135	0	0
Single do.	20	256	14·18	1	2	25	0	0
Picotta	12	290	12·52	3	...	10	0	0
Do.	5·75	368	9·86	1	...	6	0	0
Double Bucket Picotta ...	7·5	560	6·48	2	...	10	0	0
Archimedian Screw Lift ...	2	400	9·08	1	...	45	0	0
Bucket Pump, cattle power...	22	448	8·10	1	2	380	0	0
Steam Bucket Pump ...	28	840	·95	3	...	5,000	0	0
Chain Pump	12	3,250	14·52	1	1	500	0	0

Description of machine.	Daily cost.									Cost of raising 1,000 cubic feet of water.		Cost of raising 1,000 cubic feet of water 1 foot high.
	Manual labor.			Cattle labor or fuel.			Interest on capital, and cost of repairs and other charges, charged over 250 days.					
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.	A.	P.	PIES.
Double Mhote	0	3	0	0	4	0	0	1	4	2	5	1·45
Single do.	0	3	0	0	8	0	0	0	3	4	11	2·95
Picotta	0	9	0	...			0	0	1	3	5	3·42
Do.	0	3	0	...			0	0	1	0	11	1·91
Double Bucket Picotta ...	0	6	0	...			0	0	1	1	2	1·87
Archimedian Screw Lift ...	0	3	0	...			0	0	5	0	11	5·50
Bucket Pump, cattle power ...	0	3	0	0	8	0	0	3	8	3	8	2·00
Steam Bucket Pump ...	1	10	0	6	14	0	3	0	0	5	4	2·29
Chain Pump	0	3	0	0	4	0	0	4	10	5	3	5·25

Reaping Knives.—Below are shown two forms of this tool which have both been largely used on the Farm. Figure 23 was that most used at first and was found much superior to the ordinary country sickle as the following extracts show. In 1869 it was remarked :—

"From direct experiments it has been found to save 50 per cent. in the cost of cutting these crops (cholum, paddy and grass). It obtained the first prize at the Nellore Show. One gentleman states that he saves two-thirds of the labor used in cutting his grass."

And again in 1870—

"By the use of the improved grass-knife we have reduced the cost of

cutting grass, &c., to one-half. An area of grass-land for which we usually paid Rs. 10 for cutting with country knives I can now cut with the new knives for Rs. 4½; indeed the contractor offered to cut it for Rs. 5 if we would lend him our knives."

The form shown in Figure 24 is one adopted in 1879, and is designed on more correct principles than the other. It can be made for 7 annas, and all of iron or steel.

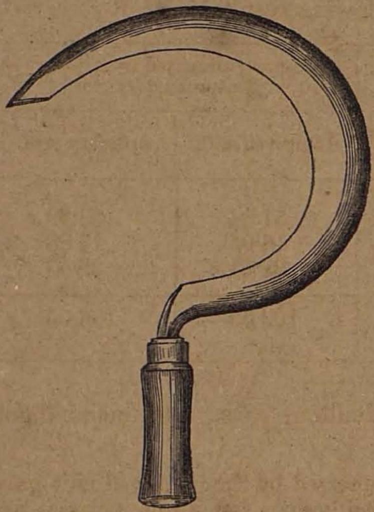


Fig. 23.

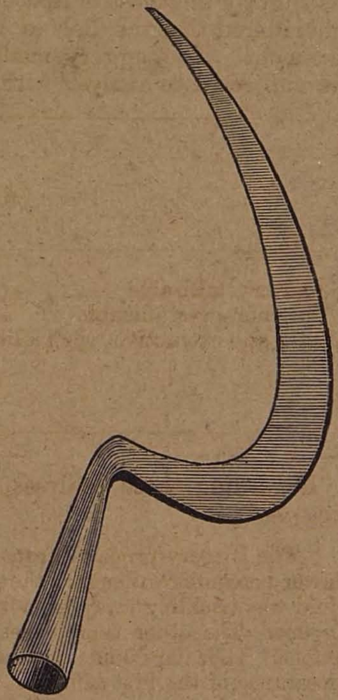


Fig. 24.

SUGARCANE MILLS.—Sugarcane is not grown in the neighbourhood of the Farm for manufacture into sugar, and the soil of it is so light and dry that only very small areas of the crop have been raised on it; but in 1879 the success of a mill for crushing cane, made by Messrs. Thomson and Mylne of Beheea, Bengal, attracted the attention of the department, and one was obtained for trial and employed on the Farm most successfully in crushing sorghum. It not being possible however, to conduct competitive trials on the Farm, and the clumsiness of the mill used there having been noticed, it was decided to make some trials in the Bellary District, which were carried out at Hospet.

The first experiments were made in 1881 with a two-roller mill. Unfortunately, one of the rollers of the Beheea mill was defective, and on this account it was necessary to put much of the cane twice through the mill. However, even with this defect cane was crushed by the improved mill at an average cost of 11 annas 10 pies per ton, whereas the cost by the ordinary mill was Rs. 1-1-7 per ton. An average day's work of each mill was—Beheea mill 2,603 lb., ordinary mill 3,359 lb., of canes crushed.

The percentage of jaggery obtained from the canes crushed by each mill was—

From the Beheea mill ... ... 11·7 per cent.
Do. ordinary mill ... 12·0 do.

The Beheea mill thus crushed the cane at nearly 50 per cent. less expense than the ordinary mill; the jaggery obtained from the latter was slightly in excess of that obtained from the former; but it must be remembered that the Beheea mill experimented with was a defective specimen. The jaggery made from the juice extracted by each mill was subjected to analysis with the following results:—

—	Jaggery prepared from juice expressed by	
	Improved mill.	Ordinary mill.
Sugar crystallizable	51·34	53·69
Do. non-crystallizable	16·05	13·88
Water and extractives with a little sand.	32·61	32·43
Total ...	100·00	100·00

Regarding these analyses, Mr. Hamilton, F.C.S., who made them, wrote:—

"The jaggery prepared from juice expressed by the improved mill gave a lower percentage of sugar; the sample had become soft, and a molasses-like liquid was trickling away from its surface as is ordinarily seen with common jaggery. The other sample has remained firm and has not liquified on its surface. It is dark and apparently slightly burnt, and has not the clean appearance of the first sample. The glucose seems high in both; there may possibly be present some unknown organic matter reducing the test, but even if this did occur, it cannot affect the results materially. What it clearly shows is, that the system of boiling in open pans in the presence of a high temperature is conducive to the production of glucose."

It is quite possible that the larger proportion of glucose or non-crystallizable sugar in the jaggery from the juice expressed by the Beheea mill may be due to carelessness in boiling the special pan of juice which afforded the sample. As noticed by Mr. Hamilton, the boiling process is a very rude one, and it is possible that the jaggery from each pan of juice may differ in the percentage of crystallizable and non-crystallizable sugar; it will be noted that the total yield of sugar differed but slightly, being in one case 67·39 and in the other 67·57 per cent., while the percentage of water in each differed almost as little.

The ryots generally approved of the mill, but considered that it was not sufficiently large and powerful for their requirements. Accordingly steps were taken to obtain for trial one of the larger mills made by Messrs. Thomson and Mylne. It reached Madras in December 1882 and was then sent on to the Bellary District. This mill was fitted with

three rollers, each 7 inches in length and 8 inches in diameter, and cost in Calcutta Rs. 162-7-0. The experiments began at Virapapur in the Hospet Taluk on the 7th February, and some of the results are recorded in the next statement.

—	Beheea three-roller mill.	Ordinary mill.	Beheea three-roller mill.	Ordinary mill.
Cost of the mill on the spot...	Rs. 175.	Rs. 80.	Rs. 175.	Rs. 80 to 100.
Weight of the mill about ...	300 lb.	3,000 lb.	300 lb.	3,000 lb.
Cost per day of power used—				
Bullocks, number and hire.	2 at 4 annas	4 at 4 annas	2 at 4 annas	4 at 4 annas
Laborers, number and wages.	3 at 3 annas	3 at 3 annas	3 at 3 annas	3 at 3 annas
Total ...	Rs. 1-1-0.	Rs. 1-9-0.	Rs. 1-1-0.	Rs. 1-9-0.
Weight of the canes when stripped and topped ...	1,800 lb.	1,800 lb.	1,800 lb.	1,800 lb.
Time crushing occupied ...	4hrs. 4min.	5 hours.	3 hours.	3 hours.
Rate of crushing in a day of 8 hours	3,541 lb.	2,880 lb.	4,800 lb.	4,800 lb.
Cost of crushing a ton of cane	Rs. 0-10-9.	Rs. 1-3-5.	Rs. 0-7-11.	Rs. 0-11-8.
Weight of juice	1,213 lb.	1,063 lb.	1,224 lb.	1,066 lb.
Volume of juice, quarts ...	589	516	594	517½
Weight of jaggery	234 lb.	207 lb.	212 lb.	200 lb.
Jaggery per cent. of cane ...	13	11·5	11·7	11·1

These results are very encouraging, and were deemed perfectly satisfactory by the ryots, in whose interests the experiments were made. It will be noticed that the Beheea mill does not weigh one-tenth of the ordinary mill and is therefore portable, and can be easily taken from field to field as required. It can be fixed in about three-quarters of an hour by ordinary coolies, whilst the country mill requires a carpenter and takes a whole day to set it up.

The following illustration shows the two-roller mill.

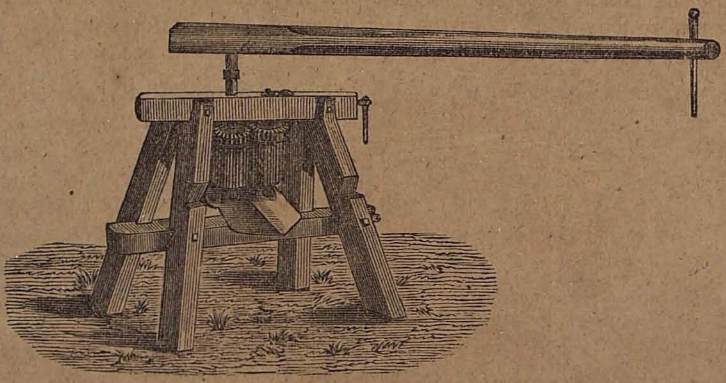


Fig. 25.

From this it will be seen that it is only necessary for the ryot to purchase the iron work of the machine, as the frame-work of wood can be put together by any carpenter.

Barn Machinery.—There is very little scope for the introduction of this class of machinery into this country. *Threshing Machines* have yet to be invented which are able to clean our ordinary cereals; with the larger ones, cholum and cumboo, the straw is too long and stiff to pass through the machines, whilst to cut the crop at two operations in the field is expensive; with the minor cereals, raggi, tenai, &c., the straw is weak and winds round the drum, and the beaters do not remove more than a quarter of the grain, which adheres most persistently to the ears; whereas with paddy a few blows of the sheaf on a block of wood does all that is required, at an extremely low cost: as long as three men can be hired for a day's work at a shilling, or until a suitable machine has been invented for our special grains, there is little, if any, probability of, or use in endeavouring to urge the introduction of threshing machines.

Winnowing Machines, on the other hand, present very many great advantages to recommend their use to the Indian ryot; at present he is altogether at the mercy of the weather, which is undoubtedly generally fine for long periods of the year, in preparing his grains for market, but did he possess winnowing machines he would be better able to take advantage of the rise and fall of prices, and to sell out his crop, not as he now does, flushing the markets and depressing the prices to his own loss in doing so, as soon as ever the crop is off the ground, but whenever the most favorable opportunity occurred for realising good prices; the increased price which enterprising men would gain by using such machines would soon repay the capital they had sunk, whilst in the end greater steadiness would prevail in the price lists of the country. The superior speed and efficiency with which a winnowing machine cleans all descriptions of grains cannot be denied, and, except for very small tenants, where the labor of the family is not counted, no doubt grain can also be cleaned much more cheaply with them. Small machines can be introduced from America at a cost of Rs. 45 delivered, at which price, the charge per diem, estimating the machine to be used fifty days annually, would be about half an anna to cover all charges for interest, wear and tear, &c.,—a ridiculously small amount. Such a machine is shown below.

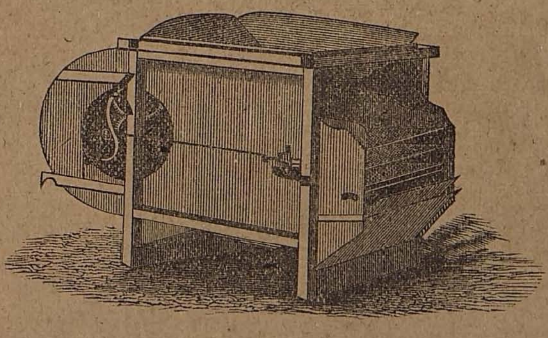


Fig. 26.

Maize Shellers.—Several varieties of these machines have from time to time been tried, but the one in use on the Farm now is an American one, the Eagle Sheller. It is very efficient and portable, and cost delivered only Rs. 40, and will shell about 800 lb. of maize in an hour. The following table compares the work and cost of it with that of two other maize shellers which have been experimented with :—

—		Ransome and Sim's.	Ainsworth's.	Eagle Sheller.
Cost of machine	Rs.	170	37½	40
Shelled per diem, cobs	lb.	3,150	4,500	10,400
Coolies required	No.	3	2	2
Cost per diem—				
Labor	As.	9 0	6 0	4 0
Interest, wear and tear, &c. ...	,,	2 8	1 6	1 7
Oil, &c.	,,	0 4	0 4	0 2
Total	As.	12 0	7 10	5 9
Cost per 1,000 lb. cobs	As.	3 10	1 9	0 6

In another experiment with the Eagle Sheller, 76,429 maize cobs were shelled in one day, which yielded 7,582 of grain. The maize used was country maize, and as the machine is fitted for large cobs, it had to be put through the machine twice and the figures are not so favorable as they would have been if larger cobs had been used. The machine can, however, be easily altered so as to fit it for shelling large and small cobs. The whole machine is very simple and is well adapted for the use of a small holder and its price is very moderate. It is shown in the next figure with one side taken out to show the interior.

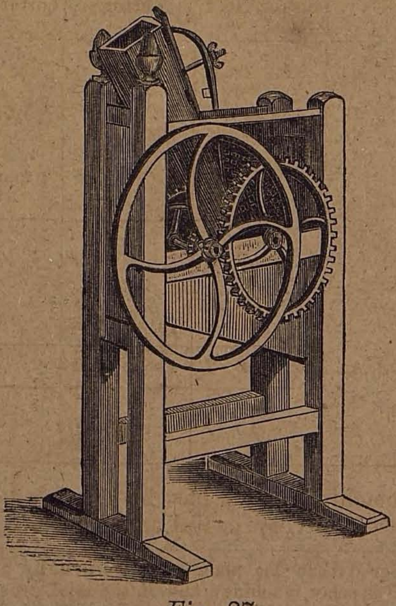


Fig. 27.

Chaff-cutters have been in constant use on the farm for many years; their value lies in economizing the food of cattle and in enabling substances, which could otherwise not be so used, to be given as fodder. From time to time chaff-cutters have been obtained from America; they are made on a different principle to English chaff-cutters. Instead of the cutting knives being fixed on the spokes of the fly-wheel, as in the English chaff-cutter, they have cylindrical knives set something like those of the lawn mower, the feeding roller being placed immediately behind the knives. The cutting action is thus continuous and less jerky than in the machines with vertical cutters, while by increasing or decreasing the speed of the feeding roller, the chaff can be cut at different lengths. They are admirably suited for cutting all sorts of thick straw; for cholum or maize straw they are especially suited. It has been found that the American machine can chaff cholum or maize straw at less cost than the English machine, though the first cost of the latter is nearly 30 per cent. less, proving that a low priced machine does not necessarily perform the cheapest work, and that an efficient machine, though its first cost may seem high, is often the cheapest machine in the long run. This is too frequently lost sight of by those who would provide the ryot only with the rudest description of implements and tools. In the instance just referred to, the extra charge for interest and wear and tear on the more costly machine is only two pies per diem, a very insignificant sum when it is remembered that with such a machine the manual labor expended will go 50 per cent. further than with the less costly machine.

In the following table the cost of chaffing with several machines is tabulated. The first three are hand-power machines.

——	American cylindrical cutter, No. 1.	English vertical cutter.	American cylindrical cutter No. 2.	Ransome's bullock-power vertical cutter.*
Cost of machine ... Rs.	50 0 0	36 0 0	40 0 0	570 0 0
Chaffed per diem—cholum or maize straw ... lb.	630	495	790	3,300
Cattle required ... No.	...	...	...	1 pair and driver.
Coolies required ... „	2	2	1 man and 1 boy	2
Daily cost of—				
Cattle power ... As.	...	...	...	12 0
Manual labor ... „	6 0	6 0	5 0	6 0
Interest, wear and tear charged over 250 days „	0 5	0 3	0 5	5 3
Oil and sundries ... „	0 2	0 2	0 2	1 0
Total As.	6 7	6 5	5 7	24 3
Cost of chaffing a ton of straw ... ... As.	10 7	12 11	15 10	11 6

The American machine No. 2 has been copied and made up in India for Rs. 36. It is a very useful machine and well adapted for

* It must be remembered that this machine is worked by a bullock power (price included), which also drives other machines, and, in the trial, crushed grain at the same time, the value of which work (Annas 7-3) is deducted.

ryots not possessing more than 20 head of cattle, for which it could easily chaff the fodder required, and would soon repay its cost in the economy of giving cut instead of uncut fodder to them.

The first American machine is shown in the next figure, but when working, has a covering over the feed roller, now shown exposed.

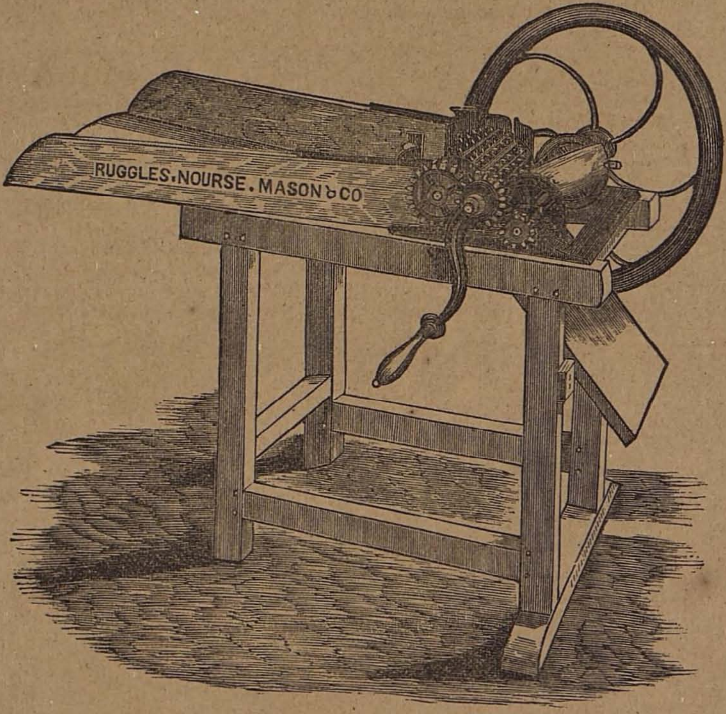


Fig. 28.

A cake-breaking and *grain-crushing* machine has been in constant use. In the following table, a summary of the daily cost of working it, as well as the same information regarding a small machine imported for a large landholder in the Tanjore District, is given.

—	Cake-breaking.	Grain-crushing.	Cake-breaking.
Cost of machine ... ... Rs.	165		59
Day's work ... ... lb.	5,400	2,400	4,200
Men required ... ... No.	3	2	2
Daily cost of—			
Labor ... ... As.	9 0	6 0	6 0
Interest, &c. ... ... „	1 0	1 0	0 4
Oil and sundries ... ... „	0 3	0 3	0 2
Total As.	10 3	7 3	6 6
Cost per 1,000 lb. As.	1 11	3 0	1 5

Cotton-gins.—Generally cotton is ginned by one of Emery's gins with thirteen saws, made by Burgess and Key; having been found to work more cheaply with cattle, that power is now always used. The following are some comparative results; they are, however, considerably better than those obtained in ordinary practice.

Nature of power used.	Cattle.	Manual.
Time working	$7\frac{1}{4}$ hours.	$7\frac{1}{2}$ hours.
Amount of seed cotton ginned ...	262 lb.	135 lb.
Would gin in a full day	315 „	162 „
Labor required—		
Coolies	2	6
Cattle	1 pair.	...
Cost of labor per diem	15 annas.	1 rup. 2 as.
Interest on capital, wear and tear, &c.	8 annas.	8 annas.
Total daily cost ...	1 rup 7 as.	1 rup. 10 as.
Cost of ginning 1,000 lb. seed cotton...	5 r. 7 a. 9 p.	12 rup. 7 p.

CHAPTER IV.

MANURES AND MANURING.

MANURING is performed either to maintain or enhance the natural productive powers of a soil, and all substances which are applied as manures act on the soil by improving its condition either mechanically or chemically. It is well known that crops extract from the land on which they grow certain mineral and nitrogenized matters which are required for its nutriment, and that, if these crops are permanently removed from the land, the amount of such substances contained in the produce will be lost to it. The capacity of a soil for furnishing plant-food being limited, in the end if cropping without returning to the soil any of the matters removed in the crop—as is usually practised on the unirrigated lands of this presidency—be continued, exhaustion must ensue. It has been abundantly proved, however, by Messrs. Lawes and Gilbert at Rothamstead, that, when a soil is cropped for some years without manure, the productive power of it is brought so low that actual inability to support plant life will be deferred for a very great and apparently indefinite length of time. The soil thus, as it were, possesses a power of protecting itself to a limited extent from the rapacious greed of the cultivator, for though it may contain abundance of the elements necessary for the support of plant life, these, being in a presently unavailable condition, are only yielded up in driblets as they become soluble. This fact also explains why the results of a chemical analysis are so often misleading, and accounts for results obtained in manuring which are otherwise altogether inexplicable.

In applying manures, the nature of the soil being dealt with must be considered, for it is often great folly to apply manures in quantities and methods to light soils which amounts and system of application would be the best in the case of strong deep soils. In India, with its burning sun and terrific heat, the gradual dissipation from the soil of the organic matters it contains must be very great, and, knowing the importance of the presence of these matters, every effort should be made to conserve and increase them.

Some manures act both by adding to the plant-food of the soil and by improving its mechanical condition, amongst which may be mentioned farm-yard manure, composts, lime, burnt clay, &c. ; other manures are simply mechanical in their action, as for instance sand when applied to a clay ; and a last great class of fertilizing substances embraces those which contribute only to the increase in the soil of the substances which plants require for their nourishment. Manures may be applied with a view to their present or ultimate effect ; for instance, a top-dressing of

saltpetre might be given to a cereal crop which was not looking healthy, with a view to stimulate its growth; but bones would be used as a dressing to add to the material condition of the soil. Some plants perfer a rich upper layer of soil, others seek for all their food deep in the soil. For the latter, manure must be applied before sowing and ploughed in, while for the former top-dressing will probably be as efficacious a manner of manuring as possible.

Experiments with Manures.—It will be remembered that in Chapter I it is explained that the whole Farm has been laid out afresh within the last few years. The great alterations, especially as regards the levels of the fields, made in doing this, have prevented manuring experiments being carried out satisfactorily in recent years. This, together with the original poverty, not to say infertility, of a great part of the Farm, has necessitated heavy expenditure in bringing the soils into fair condition. However, the soils of the fields as now laid out are, it is hoped, assuming a tolerably uniform condition. Few persons have any idea how the produce of the different parts of a field may differ in amount. Some agricultural experimentalists, instead of weighing and measuring the whole of the produce of a plot or field, select what they suppose to be an average portion and weigh and measure that only, the result being accepted as a basis for calculating the outturn of the whole area. This course is usually most misleading, for few men, even trained agriculturists, can select a few square yards of crop which is really an average portion of a whole field. On this point the following experience is instructive. A piece of land which had been under grass for four or five years was being prepared for experimental cropping, and it was necessary first to determine the natural productiveness of the soil. Before being laid under grass, the field had been recently levelled, the eastern portion especially being deeply stripped to bring it to a convenient level with the rest of the field. The following remarks regarding the plots, quoted from two annual reports, give details:—

"The field was divided into fourteen plots, each of one-tenth of an acre. These plots were ploughed, and on the 29th December 1881 the whole were sown with horse-gram (*Dolichos uniflorus*). No manure was applied. The eastern portion of the field, comprising plots 5, 6, 7 and 10, 9, 8, is somewhat lower and not so well drained as the remainder of the field, and on this portion the natural grasses had not grown so well as elsewhere. The pulse germinated well, and over the whole field the growth appeared to be very uniform; this continued until about the middle of March, after which the crop on the western side of the field became decidedly superior to that on the eastern side. The crop was cut on 11th April 1882. Before cutting, each plot was subdivided into six plots, each having an area of one-sixtieth of an acre, and the produce of each of these minor plots was separately determined—first, when the green plant was cut; next, after thrashing out the pulse. The outturn varied widely in different parts of the field. From an ordinary inspection before commencing harvesting operations, it appeared that the produce on plots 1, 2, 14, 13, and 12 was very uniform; but the figures show that there was a very considerable difference in the outturn of different parts of these plots, the green plant having varied from 2,880 lb. to 8,520 lb. and the pulse from 150 lb. to 480 lb. per acre. It is probable that had smaller areas been taken, even greater variations in the outturn would have been discovered. It is scarcely likely that any one would have made the mistake of taking any part of the

eastern portion of the field as representing the average of the whole field—at any rate not when the crop was ready for cutting—but it was almost impossible to discern any difference in the crop on the five plots above noticed."

"As has already been noticed, the object of cropping the land was simply to determine the natural state of the soil as regards its capacity to produce a pulse crop. The land will next be cropped (again without manure) with a cereal crop, and the results will be determined in the same way as those of the pulse crop. After having raised a pulse and a cereal crop on the land by its own unaided resources, it will be possible to determine something definitely regarding the physical and chemical state of the soil, after which the experiments to be conducted thereon will give information of a more intelligible nature than otherwise they would."

This was done and in the following year the remarks given below were made, it being understood that in the face of the first year's results ten of the plots on the eastern side had been rejected.

"Some further trials were made in testing the natural condition of the soil, in continuation of those noticed at paragraph 100 of the last report. It will be observed that the outturn of grain varied quite as greatly as did the outturn of pulse. The land is therefore clearly unfitted yet for experimental cropping. Efforts will be made, by mixing the soils, to produce greater uniformity in their condition. The eastern portion of the field, comprising six plots, will be rejected for experimental cultivation as altogether unfitted for the purpose. The results of these inquiries show how very necessary it is, before commencing any experimental cropping, that the character of the soil should be thoroughly ascertained. The soil of the eight plots it is proposed eventually to utilize for experimental cropping would, to the ordinary agriculturist, appear very uniform in character and composition; but, as the results of these trials show, there is a very wide difference in the producing powers of the soils constituting the different major and minor plots. There is, of course, no field which produces on every square yard of its surface exactly the same yield, and it is this irregularity in outturn, even in apparently uniform crops, that makes the practice of determining the yield of a large area by the yield of a few square yards of apparently average crop so reprehensible. The next statement gives the results of these tests."

—	Plot 1. Division 1	2	3	4	5	6	Plot 2. Division 1	2	3	4	5	6
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
First year—Horsegram.												
Green plants	48	95	151	106	114	74	142	132	118	132	116	118
Dry straw	37	36	29·5	25·5	31	21·5	45·5	32	30	29	30·2	34·5
Pulse	7	7	5·75	5·75	8	4	5·5	5	3	6	6·7	5·2
Second year—Yellow Cholum.												
Dry straw	20	44	54	80	56	56	72	80	80	76	70	56
Grain	1·75	3·5	3·75	8·25	4·5	4·25	4·5	4·75	9·75	8·75	7·75	6·25

—	Plot 13. Division 1	2	3	4	5	6	Plot 14. Division 1	2	3	4	5	6
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
First year—Horsegram.												
Green plants	109	108	115	96	89	88	78	108	74	64	76	107
Dry straw	36·25	28·5	37	31·75	25	26·75	27·5	30	16·25	16·5	28	21·5
Pulse	6·5	4·5	7	5·12	3·5	4·5	5·25	6·75	4	5·25	5	5·5
Second year—Yellow Cholum.												
Dry straw	84	82	88	82	64	100	30	56	48	80	40	60
Grain	10·5	2·75	7·5	9·75	7	10·5	2	6·25	2·5	5·75	3·75	6

The expenditure of time and labor in carrying out such an experiment as this is great, but it is unavoidable if the results of future cropping are to be intelligible and of real absolute value.

A few notes, as well as the results of experiments conducted at different times, are given below regarding the chief manures that have been from time to time made use of on the Farm. On the sandy soils, which cover the greater part of the Farm area, organic manure is the chief want, for, although they are chemically poor, their physical condition is even worse. Besides this the great uncertainty of the weather in this part of India is a very serious difficulty in the way of field experiments conducted without the aid of irrigation water over a series of years, for a single bad season may bring them to an untimely end. On the other hand, manuring experiments conducted on irrigated land are liable to serious errors by accident or carelessness in the application of the water.

CATTLE MANURE.—To provide sufficient quantities of organic manure, reliance is chiefly placed on the manufacture of it on the Farm by housing all the cattle in loose boxes, where they and the manure are protected alike from sun and rain. The manure thus made consists of the straw used as bedding, and of both the solid and liquid excrements of the cattle, which, being allowed to accumulate in the boxes during two or three months, layer by layer, and being constantly subjected to the pressure of the animals, becomes a rich homogeneous mass of a dark brown color, fitted at once for use without undergoing any preparatory process. As the cattle stalled in these boxes are all fed, in addition to green fodder, on oil-cake, the manure is necessarily rich in the more important elements of plant-food—phosphoric acid, ammonia, and potash,—as it is known that, unless animals are young and growing, nearly all the ash constituents and about nine-tenths of the nitrogen contained in their food passes into the manure. It has been found that in an average year 20 cart-loads of this manure are obtained per head of working bullocks housed in these boxes; this is only the manure made at night and during a portion of the day when the cattle are not engaged in field labor. Thus, for every pair of working cattle employed, if their boxes be always well littered, 40 cart-loads per annum of box manure can be calculated on.

The following absolute data were collected in providing a supply of manure for performing some experiments referred to further on. They include figures showing the amount of solid excrement collected and piled in a heap in the open in the manner usually adopted by native farmers, as well as the amount of ashes obtained from the bratties (cakes) made from a similar collection of dung. In 1881 the collection was made in the months of March, April and May.

Year.	Manures.	Date of beginning experiment.	Date of finishing.	Days collecting.	Hours cattle tied up.	Straw used for bedding.	Weight of box-manure.	Solid excrement collected.	Amount finally available.	Date of weighing.	Husk used in making bratties.	Ashes available.	Food. Cake.	Food. Green food.	Food. Straw.
						LB.	LB.	LB.	LB.		LB.	LB.	LB.	LB.	LB.
1880.	Box-manure ...	23rd Feb.	23rd May.	90	1,051	545	*1,716	...	1,716	...	...	...	182	2,275	2,275
	Solid excrement ...	Do.	Do.	90	1,049	...	...	2,171	784	...	...	...	182	2,275	2,275
	Brattie ashes ...	Do.	Do.	90	1,051	...	...	2,288	...	...	90	240	182	2,275	2,275
1881.	Box-manure ...	...	...	...	1,209	185	1,848	...	1,848	...	...	...	320	2,731	1,335
	Solid excrement ...	...	...	...	1,195	...	...	1,653	676	...	...	...	320	2,931	1,335
	Brattie ashes ...	...	...	...	1,200	...	...	1,636	...	...	56	171	320	2,831	1,335
1882.	Box-manure ...	9th May.	9th Aug.	92	1,467½	125	3,611	...	3,220	15th Aug.	...	...	433	Grain. 32	1,983
	Solid excrement ...	Do.	Do.	92	1,334	...	...	1,395½	491	Do.	...	...	433	32	1,865
	Brattie ashes ...	Do.	Do.	92	1,322	...	...	1,429	...	Do.	27½	119	433	32	1,895

* In this case each month's collections were by mistake removed separately.

These figures, although it is probable that some error occurred in recording the amount of bedding supplied in the second and third years, show that the average amount of box-manure which can be expected from a pair of cattle is nearly $7\frac{1}{2}$ tons per annum, and it must be remembered that the collections were made during the dry and

hot months of the year, so that the annual average would actually be greater.

In the following statement some further information on this subject is given :—

Number of the cattle boxes.	Cattle.	Number of animals.	Days accumulating.	Actual hours.	Date when weighed.	Weight of manure.	Condition of manure.
			DAYS.			LB.	
1	Nellore	2	78	On working days, 13 hours ; on holidays, 16 hours.	5th December 1882	9,200	Well decomposed.
2	Mysore	2	79		5th and 6th December 1882	6,300	Do.
3	Nellore and Aden	2	80		6th and 7th December 1882	7,000	Do.
4	Mysore	2	58		15th November 1882	6,850	Not well decomposed.
5	Do.	2	84		11th December 1882	6,630	Tolerably good.
6	Aden	2	81		8th December 1882	4,900	Well decomposed.
7	Mysore	2	53		9th and 10th November 1882	7,040	Tolerably good.
8	Half-bred young Bullocks.	2	96		23rd December 1882	5,620	Well decomposed.
9	Punganúr and Aden	2	96		23rd do.	6,050	Do.
10	Aden	2	65		15th and 22nd November 1882	5,140	Not so good.
11	Nellore	2	82		9th December 1882	8,936	Indigo straw not well decomposed.
12	Nellore and Aden	2	67		23rd and 24th November 1882	7,340	Tolerably good.
	Total ...	24	919		Total ...	81,006	

The total amount of manure obtained from these 24 head of cattle was 81,006 lb., or an average per head per diem of 3·55 lb., or at the rate of ·58 tons per annum. The Nellore cattle would weigh each 700

to 800 lb., the Mysores each from 500 to 600 lb., and the Adens from 300 to 400 lb. each. About one-third of the fodder of the animals was green. The cattle boxes were kept always well bedded, and, being roofed over, no rain water could get amongst the manure. It will be noticed that much the largest weight of manure was collected in the cattle boxes occupied by the Nellores, and that, in those in which the Adens were penned, only about half the weight of manure was obtained.

The manure is now always used direct from the boxes: formerly it was carefully stacked in heaps in the different fields in which it would be needed, but it was found necessary to give this up, as the manure in a dry season suffered so much, not perhaps by any diminution in its fertilizing ingredients, but in its physical properties: it became a fine powdery substance, very portable and easy of distribution, but altogether lost the valuable physical properties of good farm-yard manure. It must be remembered that the beneficial results attending the use of farm-yard manure are due in no inconsiderable degree to its physical action on the soil, as well as to its power of yielding to the soil the exact chemical food needed for the production of crops.

Though at the present time box-feeding will not be adopted in this country for the same object as in Europe, still there can be no reason why working, milch, and young cattle should not be kept in loose boxes at night. If we are to grow cotton, maize, &c., we must have manure, and there is no better or more economical way of making it than the loose-box system. On sanitary grounds alone the system is worth general adoption. At first sight it may appear objectionable to keep the animals for three or four months in the boxes without removing the manure; no bad results, however, arise from the practice. The working cattle have for the last fifteen years been kept at night and for a few hours at noon on this system, and the fear at first expressed that it would injure their hoofs has proved to be utterly groundless. Considerable numbers of cattle have been fattened also in loose boxes, and in no case did any of the animals have a single day's illness, though in several instances the manure was not removed for upwards of three months, whilst it had accumulated to nearly two feet in depth. Of course the excrements are not allowed to collect on the surface, the usual plan with feeding cattle being for the cattle-feeder to enter the boxes three or four times a day and throw up the bedding with a fork. No smell whatever is perceptible, and there is nothing that the most fastidious person could object to: indeed, in this respect it is much cleaner than the usual system, which allows the solid and liquid excrements to lie and decompose upon the surface of the ground. In the loose-box system the products of decomposition as well as the liquid matters are absorbed by the litter. Loose-box feeding, which has done so much for the agriculture of England, can, there is no doubt, do much for the agriculture of India.

In 1876 an experiment was commenced, but which unfortunately could not be carried to completion, to test the comparative value of box-manure and the ashes left on burning the bratties (dung-cakes) made from the solid excrements of a pair of cattle kept and fed similarly, and collected during the same period as those kept in a loose box. The experiment was stopped before completion owing to the land being required for other purposes, but the outturn obtained from

the crop of yellow cholum grown with these manures under irrigation for green fodder was as follows :—

—	First cutting.	Second cutting.	Total.
	TONS.	TONS.	TONS.
Unmanured	8·6	2·2	10·8
Manured with brattie ashes	11·7	3·0	14·7
Do. with box-manure	10·8	4·5	15·3

The fleeting action of the ashes is clearly shown even in the second cutting, and to test fully the action of box-manure figures should have been collected for several years. Besides being incomplete from being stopped before completion, the fact that the crop was irrigated was such as to require a detailed investigation as to the amount of water required by the different plots, organic manure being a well-known economiser of water. The quick action of the ashes is not surprising; the result only agrees with the experience of coffee planters and others who, in clearing a forest, burn off the timber, &c.

In 1880 some further and more extended experiments were commenced, the object being to test the relative values of box-manure, pure cattle-dung, and brattie ashes. The results of the collection have already been given at page 79 above. In the first year an error was made in the manner of collecting the box-manure, which partly vitiated the results obtained from the use of that manure, so that they cannot be fairly compared with those obtained with cattle-manure in other forms. Three pairs of cattle were set aside and their manure was collected and treated in different ways, the cattle in all cases being fed alike. From one pair the manure was collected on the box system, from another the solid excrement was collected and thrown into a heap in the open in the usual manner, and from the third pair the solid excrement, after being made into cakes (bratties), was burnt and the ashes preserved.

To test the manures thus collected twelve beds in the experimental grounds were set aside at the latter end of June 1879 and sown with horse-gram, which was dug in as a green manure in the October following. These plots were then all sown with yellow cholum, which produced a fine crop of fodder as follows :—

Plots.	Produce.	Proportional yield.	Average of pairs. Produce.	Average of pairs. Proportional yield.	Plots.	Produce.	Proportional yield.	Average of pairs. Produce.	Average of pairs. Proportional yield.
	LB.		LB.			LB.		LB.	
1	196	131	189	126	4	161	107	150	100
12	182	122			7	140	93		
2	168	112	147	98	5	168	112	168	122
11	126	84			8	168	112		
3	150	100	151	100	6	224	149	191	127
10	154	102			9	158	105		

The average outturn of all the plots was 161 lb., excluding No. 6, the large outturn for which was plainly due to some disturbing cause, probably the previous treatment.

The manures collected were applied in July 1880, and after an unsuccessful sowing of cumbu in that month, the plots were sown with Planter's friend in September, which grew well.

In the following year the experiments were continued, but it was considered necessary to ascertain the manural value of paddy straw in connection with these experiments, and two of the plots were accordingly manured with 185 lb. of paddy straw; while, as paddy husks were used in preparing the bratties from which the cow-dung ashes were made, an equivalent amount of husk ashes was added to the plots manured with box-manure, solid dung, and paddy straw. The crop grown was Planter's friend, but a drought in October nearly ruined it, resulting in a serious attack of "rust," which, occurring when the plants were in flower, proved most disastrous.

In 1882 the experiments were again continued and repeated on the same plots, so that each plot was continuously manured with the same manure for three successive years. A bad season again nearly put an end to the experiment,—the soil contains upwards of 90 per cent. of sand—and another drought in October nearly ruined the crop.

The experiments were still further continued in 1883. No manure was applied, but the plots were sown on 4th October with ragi by hand in lines nine inches apart. The crop was harvested on 3rd February 1884 with the results recorded below, to which are added those of previous years.

Plot.	Manures applied.		Produce. 1880. Grain.	1880. Straw.	1881. Grain.	1881. Straw.	1882. Grain.	1882. Straw.	1883-84. Grain.	1883-84. Straw.	Total. Grain.	Total. Straw.	Average for 4 years of pairs of plots. Grain.	Average for 4 years of pairs of plots. Straw.
			LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
1	1880	Box-manure alone ...	25	189	12	200	6	254	15	44	58	687	15¼	157½
12	1881-82	Box-manure and husk ashes.	24¾	172	6	139	5	204	28	56	63¾	571		
	1883	None												
2, 11	1880-83	None	14½	125	3	75	3	72	7	10	27½	282	9·3	83·2
			19	149	5½	119	6	100	16½	16	47	384		
3	1880	Solid dung alone ...	28¼	193	6½	125	8	164	15	18	57¾	500	15	128¼
10	1881-82	Solid dung and husk ashes.	28½	196	6½	143	6	160	22	27	63	526		
	1883	None												
4	1880	None	15¾	168	10½	136	6	104	6	7	38¼	415	9·1	117·1
7	1881-82	Paddy straw and husk ashes.	12½	177	9½	168	6	156	7	21	35	522		
	1883	None												
5	1880-82	Brattie ashes ...	18¾	201	9	136	...	81	3	6	34¼	423	11¼	122¼
8	1883	None	23½	198	9½	189	8½	152	14	16	55½	555		
6, 9	1880-83	None	Omitted.		5½	110	5½	120	10	13	21	243	8·5	89·5
			14¼	170	9	164	7¾	124	16	15	47	473		

These figures are of very little value themselves, and it is doubtful whether the experiments will be carried any further, as the land on which they were conducted has passed out of the control of the department. It is also doubtful if it is worth carrying them further.

The apparently conflicting results are probably to a great extent due to the nature of the seasons and show the necessity for continuing such experiments as these over a number of years before drawing conclusions. On soils of such a sandy nature crops are peculiarly liable to injury from drought.

SHEEP MANURE.—This has usually been collected from the sheep in covered pens—where they are kept on a bed of dry earth—which are cleaned out every morning and covered with a layer of fresh sand; the manure thus consists of this sand and the solid excrement, and has been found at various times an excellent top-dressing for grass and other crops. It has been used for paddy in the same manner, and in several cases with remarkable effect; crops that had suffered so severely from insect attacks as to be nearly condemned as useless have benefited so much by this manure as to give a fair outturn. Of late years also the practice of sheep-folding, *i.e.*, penning the sheep on the land, has been adopted. In 1881, to compare the fertilizing effect of this process with that of indigo-vat refuse, the following experiment was made. Field No. 29 was divided into two plots; one plot measured ·84 acre and the other ·94 acre. The former was manured by folding 76 sheep on it for 22 nights, which is equal to about 2,000 sheep for one night per acre. The sheep had a daily allowance of one-third pound of oil-cake per head, and were grazed during the day. The other plot was manured with indigo-vat refuse at the rate of 3 tons per acre. The land was sown with paddy, and the following are the results:—

Manure how applied.	Area of plot.	Outturn			
		Of plot.		Per acre.	
		Grain.	Straw.	Grain.	Straw.
	ACS.	LB.	LB.	LB.	LB.
By sheep-folding	·84	991	2,985	1,180	3,554
As indigo vat refuse	·94	1,299	5,208	1,382	5,540

The indigo refuse produced the best crop; probably much of this result may be attributed to the physical action of the organic matter; still, indigo refuse is undoubtedly a valuable manuring agent when it has been protected from the weather.

HORSE MANURE—has at various times been obtained in large quantities from the batteries of artillery stationed at Saint Thomas' Mount. It usually costs about one rupee for five cart-loads at the Mount. It is valuable when well decomposed, but when fresh is dangerous on account of the living grass roots it contains.

GREEN MANURING.—In dealing with the very sandy soils of the Farm, this practice has been found to be, perhaps, the most successful means for its improvement. The action of green manuring is twofold: firstly, the substance of the plant decaying in the soil leaves behind a large quantity of prepared food ready for absorption by the roots of

the succeeding crop ; and secondly, when ploughed in, the structures of the green crop add directly to the amount of organic matters in the soil, and, thus by improving its mechanical condition, add to its power of absorbing and retaining moisture, and increase the friability of stiff soils. Combined with the use of ashes, this is an especially good manuring agent. The one forms and stores up organic matter and the other supplies the minerals required by plants. Leguminous crops ploughed in green are an especially good preparation for cereals, owing to the very high percentage of nitrogenized substances which they always contain.

In the neighbourhood of Madras, "summer crops" on dry sandy land are exceedingly precarious. On the average we have not more than one year in four in which crops sown in June or July yield returns that repay the expenses of cultivation ; so that, instead of attempting to grow "summer crops" such as gingelly, cumbu, &c., except on a small scale on choice land, the wisest course after removing the "cold weather crop" is to clean the soil thoroughly, and then to sow it with horse-gram for ploughing-in or for fodder.

The practice now adopted is in the hot season, when the weather is showery, to sow with horse-gram a large area of the land then bare, the produce being either fed off by sheep folded on the land, or ploughed-in ground as green manure. Sowings like this in two or three months will produce several tons of plant per acre, which, if ploughed in, is an admirable preparation for succeeding "cold weather crops." When the seed is drilled in lines, the crop can be hoed by cattle or by hand during its growth until it covers the whole surface ; in this way weeds can be kept down and the soil maintained in a loose friable condition. During the season of 1879-80 as much as 48 acres of horse-gram were ploughed-in green with good effect.

At a high temperature and with a moist soil, such as we usually have from the middle of June till the north-east monsoon rains set in, nitrification must proceed in these soils to a very considerable extent, for, though they are deficient in lime, they contain an abundance of soda, and this base forms nitrates, which, being very soluble, would, if left in the land, be washed out by the heavy rains of the monsoon. But when horse-gram is grown, it greedily feeds on these nitrates, which, entering into organic combinations, are stored safely against removal by drainage. There must be an enormous waste of nitrates in this country when, after a very long dry season, heavy rains occur, as at the beginning of a monsoon. This shows the necessity for getting in the seed as early as possible at seed time, before the setting in of the heavy monsoon rains, in order that the young plants may take up the nitrates and hold them safe. It has, in Europe, been repeatedly shown that during a year as much as 40 lb. of nitrates per acre may be formed and stored in a good properly worked soil. Nitrates are so extremely valuable that the careful farmer should use every endeavour to utilize them thoroughly, and the plan before suggested is, perhaps, the best that can be adopted.

In 1883 six plots were laid out in field No. 15, each measuring one-eighth of an acre, with a space of one foot between each pair. Horse-gram (*Dolichos uniflorus*) was sown on the 26th June. That grown on plots 1 and 5 was fed off by sheep; on plots Nos. 2 and 6 it was

reaped and removed ; and on plots 3 and 4 it was ploughed in as green manure. Plot 1 was grazed by twenty rams from the 11th to the 15th August, the sheep being always confined within hurdles, which were moved every day from one portion of the plot, after the crop had been grazed down, to another. The sheep were sheltered during the day under a movable shed and the manure which had accumulated there during the heat of the day was evenly distributed over the plot. So long as the sheep were folded on the land they had no other food than the horse-gram, and water was brought to them to drink. The weather during the nights being favorable, the sheep were always on the land during the progress of the experiment. On the morning of the 16th August, as soon as the crop on plot 1 had been grazed down that on plot 2 was reaped and removed and the plots ploughed; and the horse-gram on plot 3 was ploughed in. Plot 5 was grazed from the 16th to the 20th August, both days inclusive, and on the morning of the 21st August, when the grazing was finished, the plots of the second series were treated in the same way as those of the first. Plots 2 and 6 gave 516 and 648 lb. of plant respectively on being reaped, or on the average 4,656 lb. of green plant per acre. Plots 3 and 4, which were green-manured, therefore probably received so much more organic matter per acre than plots 2 and 6; and plots 1 and 5, which were grazed by sheep, so much more organic matter than plots 2 and 6, *minus* the portion assimilated by the sheep. After horse-gram, yellow cholum was sown, but it was so much injured by rain that it was cut for fodder and planter's friend was sown in its stead. The following statement gives the results of the experiment :—

Plot.	Treatment.	Outturn of yellow cholum fodder		Outturn of planter's friend			
		Per plot.	Per acre.	Per plot.		Per acre.	
				Grain.	Straw.	Grain.	Straw.
		LB.	LB.	LB.	LB.	LB.	LB.
1	Grazed	162	1,296	40	632	320	5,056
2	Reaped	119	952	34	610	272	4,880
3	Ploughed in ...	140	1,120	38	494	304	3,952
4	Do. ...	234	1,872	37	617	296	4,936
5	Grazed	126	1,008	48	770	384	6,160
6	Reaped	67	536	28	616	224	4,928

The average of the results is as follows :—

Plots.	Treatment.	Yellow cholum fodder		Planter's friend			
		Per plot.	Per acre.	Per plot.		Per acre.	
				Grain.	Straw.	Grain.	Straw.
		LB.	LB.	LB.	LB.	LB.	LB.
1 and 5 ...	Grazed	144	1,152	44	701	352	5,608
2 and 6 ...	Reaped	93	744	31	613	248	4,904
3 and 4 ...	Ploughed in ...	187	1,496	37½	555½	300	4,444

The best results were, as might be expected, obtained from the plots fed off by sheep, and the next from those green-manured.

SLAUGHTER-HOUSE REFUSE.—This is obtained from the Commissariat slaughter-yards, which are situated on the Farm; it consists of blood, the solid refuse matters, and a considerable quantity of yard washings, the whole being removed daily to compost heaps. These are formed of ashes, burnt earth, weeds and other vegetable refuse, and the blood, &c., is poured over the heap, being covered each time with ashes to prevent any offensive smell being given off. These compost heaps are placed in pits excavated for the purpose, made to hold from 50 to 80 loads. After the proper depth has been reached, generally from four to five feet, the whole is allowed to stand for two or three months, and then, when opened, the manure is found to be in the best possible condition for immediate use, having quite lost all its former unpleasant properties, and assumed a condition in which it is impossible to determine what it was originally composed of. In this state even caste coolies make no objection to work amongst it. The manure thus prepared is very valuable for all kinds of crops, especially for such as sugarcane, maize, &c., which require highly nitrogenized manures. For grass and fodder crops it is also of great value, and, being of very fine texture, is more useful in the dry season than farm-yard manure, which tends to open the soil to which it is applied.

The following experiment was made in 1880-81 to test this material. Field No. 10 was divided into two equal sized plots; one—A—was manured with 8 tons of box-manure and the other—B—with 8 tons of slaughter-house refuse, both manures being spread broadcast and ploughed in. The field was sown on 1st October with maize and cotton, but the maize failed. The cotton was sown in lines alternately 1 foot and 5¾ feet apart. The following table shows the results :—

Plot.	—	March.	April.	May.	June.	July.	August.	September.	Total and Average.
		LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
A.	Cotton in seed ...	16	6·5	49·75	97·5	38	54	18·75	280·5
	Lint	5	1·75	16·	24·	12	16	5·5	80·25
	Percentage of lint ...	31·3	26·9	32·2	24·6	31·6	29·6	29·3	28·6
B.	Cotton in seed ...	13·5	8·25	29·5	74·25	31·75	24·25	24·	205·5
	Lint	4·25	2·5	7·25	18·75	10·25	7·75	8·25	59·
	Percentage of lint ...	31·5	30·3	24·6	25·3	32·3	31·9	34·4	28·7

COTTON SEED—when steeped to destroy its vitality, is undoubtedly one of the best manures we possess, and is suited for any crop we grow, more especially the cotton crop. In cotton seed there is a large quantity of fertilizing matter concentrated in a very small bulk; it is thus well suited for coffee or tea planters, and where, in order to reduce the cost of transit, it is necessary to get a portable concentrated manure. Though at first sight it may appear rather a wasteful practice to use cotton seed as a manure, especially as the oil it contains,

though valuable in feeding, is worthless as manure, it is nevertheless a practice to be recommended until some cheap and effective means of removing the outer husk of the seed has been introduced. Cotton seed is used to some extent as a cattle food; but it is not a safe food to give, except in very small quantities and along with succulent fodder, as the fibre, part of which invariably adheres to the seed, sometimes collects in balls in the stomach, and produces serious and often fatal derangement of the digestive organs. Cotton seed in 100 parts contains about 9·5 moisture, 86·5 organic matter which contains 7 of nitrogen, 1·7 phosphates of lime and magnesia, and 1·75 alkaline salts.

CASTOR CAKE—has been generally used as a top-dressing after being first pulverized, and is applied at the rate of 200—1,000 lb. per acre. It is used on both unirrigated and irrigated crops. On the latter the result is, in most instances, very satisfactory, but on the dry crops little effect is noticed. However, little else can be expected as the cake probably remains long inert in the dry land, though still available as plant food when favorable conditions arise. The cake is especially rich in nitrogen; it is therefore a powerful fertilizer; its action is slow, but, when mixed with cattle manure, it becomes a great deal more active and more fitted to meet the wants of quick-growing crops.

Mr. Hughes in his report on the Ceylon coffee plantations gives the following analyses of this cake:—

——	White decorticated; average of 2.	Undecorticated.	
		Black.	Brown; average of 3.
Moisture	9·68	9·98	8·66
Oil	13·02	4·03	7·60
Albumenous compounds *	46·59	28·01	27·91
Digestible fibre, &c.	11·41	18·84	21·78
Woody fibre	9·01	28·22	27·62
Mineral matter †	10·29	10·92	6·43
Total ...	100·00	100·00	100·00
* Containing nitrogen	7·45	4·48	4·47
† Do. sand	2·69	5·05	1·52
† Do. valuable ash	7·60	5·87	4·91

Regarding these figures he remarks:—

"The above results at once indicate that white castor cake is much superior as a manure to black or brown castor. The great superiority consists in the larger percentage of nitrogenous compounds, also a higher proportion of valuable mineral constituents, such as phosphates of lime, magnesia, and alkaline potash salts. Another advantage associated with white castor is that the proportion of woody fibre is much less, at least 20 per cent. In the specimens of brown or black castor a great deal of this fibre is due to the presence of husks from the original seed, and which are naturally of little value as a manure. The quantity of oil is much larger, it will be observed, in the white castor, but this does not make the cake any more valuable as an immediate plant fertilizer.

"For all practical purposes a determination of the quantity of nitrogen in samples of castor cake is all that is necessary in order to judge of the quality as a manure, for a glance at the above analysis will show that the

higher percentage of nitrogen is associated with the smallest quantity of woody fibre, and at the same time the most available ash. By 'available ash' I mean the quantity of mineral constituents left after deduction of the sand from the total ash.

"As to the important question of using white or brown castor as a manure, I should consider the former at least 30 per cent. more valuable, so that for long distances it will probably be decidedly the most economical. This is, assuming that it contains from 7 to 7½ per cent. of nitrogen as compared with 4½ per cent. in brown or black castor. Indeed, white castor cake must be considered as a very rich and exceedingly stimulating manure."

BASSIA-NUT CAKE—called in Tamil illupu, is obtained from seeds of the *Bassia longifolia*, a tree which emits a disagreeable smell when flowering, resembling that met on entering a filthy stable. Applied at the beginning of the rains, the manure is slow acting but useful. One hundred parts of this cake consist of about 13·5 parts of moisture, 81 parts of organic matters containing 2·73 parts of nitrogen, 1·43 parts of phosphate of lime and magnesia, 3·63 parts of alkaline salts, and the remainder of sand.

VILLAGE NIGHT-SOIL.—For several years a large quantity of poudrette was made, the excreta being collected in the Wudder settlement which was formerly situated on the Farm. Latrines were provided for the use of the people and a scavenger was employed to collect and remove the solid excreta. At the place set apart for the purpose, the excreta was, as it was gathered, thrown into a heap, and the whole covered each time with a slight coating of ashes to prevent any offensive smell. When the heap had accumulated to about 20 or 25 cart-loads, it was finally covered with ashes and soil, and a fresh heap begun. After lying in the heap for about eight or nine months, the night-soil was found to be quite deodorized and fit for use. In this state coolies made no objection whatever to work with it; indeed, the character of the manure is so thoroughly changed, that few persons could, from its appearance alone, determine the nature of its original ingredients.

The following experiment was made to test the value of this material. Two plots, each half an acre in extent, of poor light sandy soil were selected and sown with yellow cholum on 14th October 1875. The plants appeared above ground in five days, and during the growth of the crop it was once bullock and once hand-hoed. The duration of growth was 115 days, during which time 21·29 inches of rain fell in 26 days. The poudrette was applied at the rate of 40 loads per acre; the results were as follow :—

—	Yield of	Per plot.	Per acre.
		LB.	LB.
Unmanured	Straw ...	2,198	4,396
	Grain ...	193	386
Manured	Straw ...	3,108	6,216
	Grain ...	186	372

It is possible that the heavy dressing of manure killed a number of young seedlings from the solubility of the salts it contained. It must also be remembered that the poudrette did not contain any liquid excreta, which contain five-sixths of the valuable portion of human excrement.

Alluvial earth.—Large quantities of this valuable substance have from time to time been raised from a deposit which underlies a great portion of the Farm. When raised it comes out in blocks, but after full exposure for six months it crumbles down to a fine powder, in which condition it makes an excellent surface-dressing for our sandy soils; not only does such a dressing greatly improve their physical state, but it also considerably increases their fertility by supplying the food needed by crops.

Phospho-guano.—Small supplies of this valuable manure have been purchased at various times for use in field experiments. This manure has been long and favorably known in England and in Germany. Its high fertilizing qualities have again and again been noticed by Liebig, Voelcker, and others. The manure contains, in round numbers, about 39 per cent. of soluble phosphate of lime, about 6 per cent. of insoluble phosphates, nearly 4 per cent. of ready-formed ammonia as non-volatile ammonia salts, and some potash. It has been ascertained that the manure is very efficacious as an application for preventing sugar-cane cuttings from being attacked by white-ants, and it must be remembered that it at the same time affords the food needed by the sugar-cane during its growth.

Bone dust—consists of minutely pulverised bones, so prepared in order to facilitate distribution over the surface of the land. This minute state of division is not generally necessary, and the dishonest dealer can with much more ease adulterate bone dust than he can adulterate bones which are simply broken; while for all practical purposes quarter or half inch bone is equally effective, not perhaps in the immediate, but in the general result. All the different preparations of bones, whether boiled bones, crushed bones, bone dust, bone black, or super-phosphate, are valuable to the farmer, chiefly in yielding calcium phosphate. Though in the raw state bones yield a large percentage of ammonia, still it is as a means of adding phosphoric acid to the soil that they are chiefly employed by the farmer, which substance all cultivated crops appropriate largely; and not only crops, but every animal the farmer rears removes from the soil large quantities of phosphoric acid in building up its internal framework of bones, muscles, &c. Assuming that the bones of an average sized country bullock weigh 50 lb., containing 55 per cent. of calcium phosphate, and an average sized sheep or goat 10 lb., containing a similar percentage, it is not difficult to explain in what way the soils of the ryot on which stock are reared fast become exhausted in phosphates or bone material. Bones are costly in this part of India, and their collection a matter of difficulty; but assuming the annual death-rate of live-stock to be 10 per cent., nearly nineteen thousand tons of calcium phosphate annually disappear. This would provide enough phosphoric acid for a million tons of our chief food-grains.

ANIMAL OR BONE CHARCOAL—has been used several times. It is a very inert, slow acting substance, and, though of value as it contains a large percentage of phosphoric acid, immediate results can never be hoped for from its use. With the idea that by mixing it with decaying organic matters some portion of its constituents might be rendered soluble by the action of the acids and heat generated in the process of decomposition, several experiments, the results of which are recorded below, were made during the season of 1877. It is, however, difficult to say whether the increase, which is shown to be obtained by use of cake and bone charcoal mixed some time before application, is due to the partial decomposition of the cake or to any dissolution of the constituents of the charcoal.

Crop	Yellow Cholum.		Planter's Friend.		Maize.		Sumba Paddy.	
Manure per acre ...	330 lb. bone charcoal. 380 lb. cake. Freshly mixed.	330 lb. bone charcoal. 380 lb. cake. Mixed and allowed to decompose.	372 lb. bone charcoal. 426 lb. cake. Freshly mixed.	372 lb. bone charcoal. 426 lb. cake. Mixed and allowed to decompose.	372 lb. bone charcoal. 426 lb. cake. Freshly mixed.	372 lb. bone charcoal. 426 lb. cake. Mixed and allowed to decompose.	1,333 lb. fresh cake.	599 lb. bone charcoal. 734 lb. cake. Mixed and allowed to decompose.
Area of plots in acres ...	·655	·655	·16	·16	·16	·16	·3	·3
Yield per plot, straw ...	LB. 3,517	LB. 3,685	LB. 2,760	LB. 3,058	LB. 506	LB. 408	LB. 1,145	LB. 1,337
Do. grain ...	10½	10¾	25½	23	* 296	* 236	267	227
Yield per acre, straw ...	5,369	5,626	16,500	18,348	3,036	2,448	3,816	4,456
Do. grain ...	16	16	115	138	* 1,776	* 1,416	896	756

* Cobs.

The yellow cholum crop was sown on 4th October 1877, and the manure was applied when the crop was about 6 inches high on the 16th of the same month; it was harvested on 11th January 1878, having been on the ground 99 days, during which 30·13 inches of rain fell in 29 days, of which 29·27 inches in 27 days were registered after the application of the manure. The soil of the field is for the most part a light sandy loam, but, being rather steeply inclined, is exposed to considerable surface wash. The planter's friend crop is referred to below, at page 104 where all particulars regarding the crop are given. The maize crop was sown in a field only recently levelled, and the results obtained with it are therefore open to great doubt owing to the uneven quality of soil; they are further in a measure vitiated as regards the weight of cobs obtained by the number stolen from the field before harvest. The crop was sown on 24th September and was 89 days on the ground. The manure was applied on 14th October, and out of the total rainfall of 32·22 inches in 34 days, which the crop received, 29·47 inches fell in 28 days after that date.

SALTPETRE—has from time to time been largely used; it is easily obtainable in many districts of the presidency, in a state fit for use, at a reasonable price. It is a good manure for cereals generally, but is most effective when employed on soils already in good manural

condition, or when used as an auxiliary manure along with some organic substance. It has been used sometimes with great success, but at other times with little. In 1877 several experiments were made with it as a top-dressing in different amounts, with a view to determine the most profitable rate at which to apply it, but, owing to the character of the season, these were not satisfactory; in the following table, however, the results obtained with a crop of Sorghum are given.

——		Unmanured.	60 lb. saltpetre per acre.	90 lb. saltpetre per acre.	120 lb. saltpetre per acre.
		LB.	LB.	LB.	LB.
Yield per plot.	Straw ...	4,437	4,364	4,514	5,296
	Grain ...	167	208	490	160
Do. per acre.	Straw ...	8,874	8,728	9,028	10,592
	Grain ...	334	416	980	320
		RS. A.	RS. A.	RS. A.	RS. A.
Value of produce per acre ...		42 15	42 3	45 5	48 2

The crop was sown rather late, but came up extremely well. The land had been manured by ploughing in a crop of horse-gram, but no great depth of cultivation was attained. The soil is rather light and sandy, and on that account not likely to give great returns from the use of saltpetre. The weather also, after the application of the top-dressings, was not at all advantageous, for after 11th December, the date on which they were applied, only ·51 inch of rain fell during the remaining period of growth of the crop, an amount perfectly inadequate to bring out the full action of saltpetre.

The next experiment recorded was made in 1878-79 in top-dressing sugar-cane with this substance. The soil of the field is of a stiff and adhesive character, its nature not being due to the presence of clay, but to its physical state. The land was prepared for planting by scarifying and harrowing it twice, and ploughing and subsoiling it to the depth of about a foot; it was then rolled and trenches were made with the plough about 4 feet apart, which were deepened subsequently by hand labor. The whole field was manured with slaughter-house refuse before planting at the rate of 12 tons per acre. Two varieties of sugar-cane being planted, a white variety and a red variety; the shoots of both were obtained from Bangalore. The sets were placed in the trenches about 1 foot apart and were covered with a little soil; this was done at the end of January 1878 and the field was constantly watered for some days after. When the shoots were about 1½ feet high, saltpetre was applied to plots each one-thirtieth acre in area, at the rates mentioned in the following table:—

Saltpetre applied per acre.		Outturn.				
		Number of canes.	Weight of canes.	Weight of straw.	Total weight.	Total per acre.
			LB.	LB.	LB.	LB.
White cane ...	337½	380	856	224	1,080	32,400
	None.	381	781	192	973	29,190
	450	215	463	94	557	16,710
	225	172	402·5	94	496·5	14,895
	112½	146	188	2	190	5,700
Red cane ...	450	265	315	364	679	20,320
	225	225	244·5	224	488·5	14,655
	None.	225	224	250·5	474·5	14,235
	112½	125	119	224	343	10,290
	337½	71	78·5	120	198·5	5,955

During the growth of the crop it was hoed five times and was watered whenever necessary. As this water had to be raised a considerable height by bullock labor, the expense was very great. At the end of July, 15 tons of horse manure per acre were applied to the crop with a view to accelerating its growth. Owing to the attacks of white-ants from the very commencement the crop was very patchy, and about the middle of December, some time before the canes had fully matured, it was so severely attacked by rust as to necessitate its being cut down, so that the results obtained must be received with caution, neither the soil nor the other conditions of growth being favorable. The results given are the averages of two plots of white and red cane respectively. As the great variations show, the value of these results is small; they appear, however, to show that saltpetre is of doubtful value for this crop on such land.

In the next table some results are given on the effect of top-dressing indigo with this manure. The experiment was made in 1882 on plots, each measuring 484 square feet.

Plots.	Manure applied to each plot.	Average produce			
		Per plot.		Per acre.	
		Seed.	Straw.	Seed.	Straw.
		LB.	LB.	LB.	LB.
1 and 5	20 lb. saltpetre	44	166	3,960	14,940
3 and 7	200 lb. gypsum	41½	151½	3,735	13,635
2 and 4	Nothing	40	181	3,600	13,590
6 and 8	Do.	33	138	2,970	12,420

Common Salt—has been used occasionally as a manure, but its high price is almost prohibitive to its use in this manner, whilst the proximity of the Farm to the sea renders it doubtful whether it is ever likely to be required. The following results of an application of it to a crop of ragi, which plant is looked upon by a ryot as a salt-feeder, are, however, recorded. Ten plots, each measuring 408⅜ square yards, were laid out in field No. 11, running north to south, the drainage of the field being in that direction, so that the salt applied

to one plot might not be washed into another plot. A foot space was left between every two plots. When the ragi crop was 26 days old it was bullock-hoed and the salt applied and hoed in next day. To ensure uniform distribution, the salt was mixed with enough sand to make the mixture in the case of each plot up to 500 lb. The following statement shows the results :—

Plot.	Salt applied per plot.	Outturn.			
		Per plot.		Per acre.	
		Grain.	Straw.	Grain.	Straw.
	LB.	LB.	LB.	LB.	LB.
1 and 6	...	128½	481	3,034	11,714
2 and 7	10	132	470	3,129	11,140
3 and 8	20	141½	511½	3,356	12,123
4 and 9	30	137	517	3,257·5	11,661·7
5 and 10	40	138½	536½	3,282	12,717

The plots were small and narrow, and the figures do not show any decided result. However, there was a marked difference between the experimental portion of the field and the remaining part as regards the outturn of the crop, as the following statement shows ; the difference may, however, not be due to the salt applied.

——	Area.	Grain.	Straw.	Grain per acre.	Straw per acre.	Ratio of grain.	Ratio of straw.
	ACRES.	LB.	LB.	LB.	LB.	LB.	LB.
Experimental plots ...	·85	1,355	5,032	1,505	5,591	100	100
Non-experimental portion.	2·11	1,855	8,126	900·5	3,944	59·8	70·5

Another experiment with salt was made in field No. 12 as a top-dressing for *Sorghum saccharatum*. The area occupied by the crop was 1 acre ; half an acre was dressed with 250 lb. gypsum, on the 29th December, when the crop was about 44 days old ; one-twelfth acre was dressed with 16¾ lb. salt, or about 200 lb. per acre, on the 15th December, when the crop was about a month old ; and the intermediate portion of the crop, five-twelfth acre, was left unmanured. The salt was mixed with sand for even distribution over the plot. The following statement compares the outturn of the plots :—

——	Area.	Grain.	Straw.	Grain per acre.	Straw per acre.	Ratio of grain.	Ratio of straw.
	ACRE.	LB.	LB.	LB.	LB.	LB.	LB.
Dressed with salt ...	$\frac{1}{12}$	60	960	720	11,520	100	100
Do. with gypsum...	½	180	940	360	1,880	50	16·3
Unmanured	·625	56	728	89·6	1,164·8	12·4	10·1

The experiments were not duplicated, and therefore can scarcely be trusted.

Calcium Sulphate, Gypsum or Sulphate of Lime—the refuse of the sodawater manufactories, has been used with considerable success. Natural gypsum is difficult to procure near Madras. The former is

not chemically pure calcium sulphate, as it contains, besides calcium carbonate, various chlorides and sulphates of calcium and sodium; but on this account it is none the less valuable as a manure, while near Madras it is far less costly than the natural sulphate. The Farm soils being very poor in lime, this manure is of great value to them, but its special value is as manure for leguminous crops. As a constituent of compost heaps containing decomposing nitrogenized matters it is of special value in arresting the escape of volatile ammonia, the sulphuric acid it contains having a stronger affinity for ammonia than for the lime with which it is in combination. There are no deposits of natural gypsum, it is believed, nearer Madras than the Trichinopoly District; it has also been tried, but it costs nearly 20 rupees a ton delivered on the Farm.

Some small experiments were made in 1881 to test the effect of gypsum on the amount of crystallizable sugar in Sorghum. Under the name of "plaster," it is very largely used for this crop in the United States. The following extract refers to the manufacture of jaggery from some Minesota early amber sugar-cane manured with gypsum and without it.

"Not having been able to obtain suitable apparatus for making sugar, I confined the experiment to the manufacture of jaggery. The results of the various determinations are tabulated below.

Experiment.		Canes crushed.		Weight of heads.	Yield of juice.		Yield of jaggery.			Remarks.
Number.	Date.	Number.	Weight.		Weight.	Per cent. of cane.	Weight.	Per cent. of juice.	Per cent. of cane.	
			LB.	LB.	LB.		LB. OZ.			
1	18th Oct.	50	47	4	17¾	37·76	1 6	7·74	2·92	Soil dressed with gypsum.
2	18th do.	50	49	4	20¼	41·32	1 12	8·64	3·57	
3	22nd do.	50	49	5	17¼	35·20	2 3	12·68	4·46	Soil dressed with gypsum.
4	22nd do.	50	45	4¾	16	35·5	2 5	14·45	5·13	
5	28th do.	66	50	...	24½	49·0	3 0	12·24	6·0	
6	28th do.	82	50	...	26	52·0	3 1	11·77	6·12	

"Mr. Hamilton, F.C.S., Chemical Lecturer in the Agricultural College, was good enough to make analyses of the jaggery produced. The following is his report:—

—	Amber cane jaggery from plants grown		
	Without gypsum.		With gypsum.
	1	2	3
	PER CENT.	PER CENT.	PER CENT.
Crystallizable sugar	68·98	65·91	65·91
Non-crystallizable sugar	15·75	14·24	14·24
Water and extractives	15·27	19·85	19·85
Total ...	100·00	100·00	100·00

" 'REMARKS.—The samples are of varying appearance. No. 1 is more consistent and lighter in color than the other two; the crystallizable sugar in this sample is in a finely granular condition. Nos. 2 and 3 are of a darker color; the crystals are more abundant, and are deposited in the bottom of the vessel beneath the dark supernatant syrup. No. 3 is somewhat darker from the presence of caramel due to slight burning.

" 'The examination of the jaggery was made with an average sample prepared by intimately mixing the syrup and sugar in each vessel.

" 'Taking into consideration that the process employed on the Farm is of the simplest description, the results are very favorable. The quantity of non-crystallizable sugar is high in all the samples, but this may be due to some defect in the preparation of the syrup by which the crystallizable sugar had suffered change by 'inversion.' The proportion of glucose in the freshly expressed juice is small, as I have ascertained. If, therefore, precautions were taken to avoid fermentation, there is no doubt that a larger outturn of crystallizable sugar would result. The juice decomposes quickly when exposed to the action of the air.

" 'The quantity of the jaggery was determined by Fehling's gravimetric copper process: this method was selected owing to its general adoption by chemists in the United States, and will be useful for comparison with the published analyses of sugars from American-grown cane.

" 'If the necessary means for controlling the fire were available in boiling the clarified juice, the syrups could doubtless have been submitted to further concentration, the presence of the water showing a relative decrease in the three samples in the proportion of crystallizable sugar.

" 'No. 1 shows an apparent increase in the total quantity of sugars, which can be accounted for by the greater concentration of the syrup in this case. The uniformity in the results obtained from Nos. 2 and 3 is striking. The manure used does not appear to have influenced the production of sugar.' "

"The juice, on leaving the mill, contains glucose, besides cane sugar and an acid. When the canes are not sufficiently ripe there appears to be more glucose present. Lime was used to neutralize the acid, but even in neutral solutions of juice, fermentation converts cane sugar into glucose, a result also produced by concentrating the juice in open pans."

At the same time, another small experiment was made with the same substance applied to maize, but the results were of no particular value in respect to the effect it has on the sugar in the stems. They are, however, given in the next chapter under the heading of maize, at page 128.

LIME (*Calcium carbonate*).—The use of this mineral as a manure is totally overlooked in native agriculture, and perhaps fortunately so, for if the ryot knew the stimulating qualities of a dressing of lime on the soil, he would soon deprive it of the small reserves of plant-food it contains, and leave it utterly barren. The mineral is easily obtainable in many localities and might be applied to some soils with great advantage, but cannot be recommended for use except under enlightened management, for it has long been said of lime that "it enriches the father and impoverishes the son," in this referring to the use of it in excess. As a manure for leguminous crops it is very valuable.

It is obtainable here in the form of burnt shells (marine and freshwater), such as are used for preparing shell chunam in the Madras

District; they yield an almost pure carbonate of lime, containing an exceedingly small quantity of impurities, which after being slaked forms a light powder, that can be spread over the land with great facility. But at the rate prevalent in Madras this is a costly way of obtaining lime for agricultural purposes. The cost is at least 50 per cent. in excess of the cost of equally good lime in the agricultural districts in England. The high price of fuel is the great bar to the use of this mineral as manure; but, where near large towns considerable accumulations of organic refuse, consisting of sweepings, &c., exist, there appears to be no reason why limestone should not be burnt for agricultural purposes at a very low cost, as these accumulations would provide excellent fuel for the purpose, while the ashes made would of themselves form a valuable manure. Nodular limestone can, in most places, be obtained at very easy distances.

The following are the analyses of three sorts of limestone found in this presidency :—

—	Limestone from		
	Vellicherry.	Poontoor.	Cuddapah.
Calcium carbonate	70·0	75·4	76·90
Moisture	1·2	2·0	2·85
Clay, sand and other substances insoluble in hydrochloric acid.	28·8	22·6	20·25
Total ...	100·0	100·0	100·00

Shell lime has been frequently used as a manure for indigo; it costs about 5·3 rupees a ton slaked. To test its effect on this crop an experiment was made in 1881. The western portion of field No. 15, about 3 acres in extent, was divided into three plots; one plot was unmanured, one plot received 17 parahs of lime, and the other plot was manured with 34 parahs of lime. A parah contains 4,000 cubic inches and costs about 4½ annas. The lime was slaked before being applied. The following statement shows the results :—

Manures applied.	Value.	First cutting.		Second cutting.		Third cutting.		Total outturn.		Value.
		Bundles.	Weight.	Bundles.	Weight.	Bundles.	Weight.	Bundles.	Weight.	
	RS.		LB.		LB.		LB.		LB.	RS.
None	...	40	2,240	17	874	31·5	1,718	88·5	4,832	12·64
17 parahs of lime ...	4·95	43	2,408	22	1,186	44	2,528	109	6,122	15·5
34 do. do. ...	9·91	61	3,416	20	1,032	44·5	2,625	125·5	7,073	17·56

The next recorded experiment was made in 1881-82 to ascertain the effects of lime on the arrowroot plant, as regards its yield of starch. Plot C was dressed with 30 lb. of slaked lime, equal to an application

of 2,017 lb. per acre; the other two plots received no lime. The following are the results :—

Plot.	Area.	Actual outturn.		Per acre.	
		Tubers.	Starch.	Tubers.	Starch.
	SQ.YD.	LB.	LB.	LB.	LB.
(A) no lime	72	82	4	5,512	269
(B) Do.	72	161	6	10,823	403
(C) 3 lb. lime	72	158	18·50	10,621	1,244

The tubers in plots A and B were very small and much diseased, whereas those in plot C were of a fair size and generally sound. As the soils were identical and the treatment similar in every respect, the great superiority of the crop of plot C can, therefore, be attributed only to the effects of the lime.

In 1883, the following experiment with slaked lime was made in field No. 12. Two plots, each ·90 acre, were laid out. To one of them, plot B, 9 cart-loads of slaughter-house refuse and 900 lb. slaked lime were applied, and to the other, plot C, 9 cart-loads of slaughter-house refuse only. The outturn of cotton from the two plots was as follows :—

Plot.	Area.	Cotton in seed	
		Plot.	Per acre.
	ACRE.	LB.	LB.
B, limed	·90	408	$564\frac{4}{9}$
C, no lime	·90	314·5	$349\frac{4}{9}$

ASHES.—Large quantities of ashes from brickyards, houses, &c., have been used with fair results, but the soils of the Farm are generally more benefited by organic than by mineral manures. In one case a sample of ashes, which was said to be obtained from a brick-kiln, was found to contain 6 per cent. of moisture; 20·60 per cent. of the sample was soluble in hydrochloric acid, of which 3 per cent. was soluble in water; of the 80 per cent. insoluble in hydrochloric acid, 10·37 per cent. was soluble in boiling caustic potash; and of the remainder, more than 60 per cent. consisted of sand and charcoal. In the portion soluble in hydrochloric acid there was no less than 3·874 per cent. of phosphoric acid and a fair percentage of potash, lime and soda. The fuel used in the kilns is chiefly wood, but this could not possibly account for the large quantity of phosphoric acid found. It is customary to use a small quantity of dried cow-dung fuel when the kilns are first lighted, but the quantity used is quite insufficient to account for the large percentage of phosphoric acid. The only possible explanation is, that, probably, the contractor who supplied the ashes to the Farm obtained a portion of them in some "burning ground" instead of from brick-kilns, as stated by him.

The ashes used are obtainable in Saidápet at the rate of one or two annas a cart-load, a price which shows how little they are prized in the neighbourhood. Paddy husk containing a large percentage of valuable plant food, and especially phosphate of lime, must yield in the ash a most valuable manure for raising grain crops; these ashes are easily obtainable and cheap. A compost of oil cake and paddy husk ashes has been frequently applied with good results as a top-dressing to paddy land.

In 1880-81 four plots in Division E of the Botanical Garden were manured as shown below, and sown with horse-gram (*Dolichos uniflorus*) with the results recorded.

Plot.	Manure.	Outturn of seed.	Outturn proportional.
		GRAMMES.	
7	60 lb. bone-charcoal	285	356
13	3 parahs village ashes ...	315	393
14	2 do. do. ...	275	343
15	1 do. do. ...	125	100

A parah (4,000 cubic inches) of ashes weighs about 80 lb. when air-dry, and ashes generally contain considerable quantities of lime in various forms. The Farm soils generally are incapable of producing good crops of pulses, probably owing to their containing a very small amount of lime; and the results given above tend to confirm this, as the result of applying lime in considerable quantity was a very good outturn; that from plot 13 being at the rate of 839 lb. per acre.

MISCELLANEOUS EXPERIMENTS.—It must be remembered that those referred to below do not form a tithe of those which have been made, the results of which have not, from various causes, been fit for report, or have not been considered worth repetition here.

In 1872, a portion of a field planted with maize and Hinginghat cotton was divided into plots, each containing 2,500 square yards, and the top-dressings given in the table below applied to the maize crop with the results mentioned. In the calculation half the gross area of each plot is deducted as having been occupied by the cotton crop.

Number of plot.	Top-dressings applied per acre.	Produce				Increase per acre.	
		Per plot.		Per acre.			
		Cobs.	Straw.	Cobs.	Straw.	Cobs.	Straw.
		LB.	LB.	LB.	LB.	LB.	LB.
3	None	150	588	580·4	2,276	..	..
1	Lime—968 lb.	219	1,008	847·9	3,902	267·5	1,626
2	Animal charcoal—484 lb. ..	160	806	619·5	3,120	39·1	844
4	Gypsum—968 lb.	178	724	689·2	2,803	108·8	527

Besides the top-dressings, the whole of the land was manured with farm-yard manure at the rate of about 8 tons per acre. It will be

seen that the dressing of lime produced 267·5 lb. of cobs and 1,626 lb. of straw per acre more than the plot simply manured with farm-yard manure; in this instance the cost of the lime was repaid by the crop to which it was applied, while there is not the least doubt but that the beneficial effects of this dressing were working for several years on the crops afterwards grown on this land. In these experiments gypsum was not so effective as lime, though it is a well known fact that this substance is of especial value as a manure for the maize crop; probably, the superior efficacy of the carbonate over the sulphate in this instance may have been due to the action of the former on such a soil (a stiffish one in a sour condition) as that on which these experiments were conducted, in restoring a healthy condition, and in rendering insoluble silicates soluble and fit for assimilation by the growing crops. The inefficiency of the animal charcoal in these experiments is the action usually noticed.

Another set of experiments of a similar nature was made on a yellow cholum crop, on plots, each measuring 2,000 square yards. The soil on which these experiments were conducted is stiffer than the majority of our soils. The top-dressings were applied at about the end of the second week in October, and though doubtless a large proportion of the more soluble portions were washed off the land by the heavy rains which fell about the time, the results were more satisfactory than those of top-dressings applied ten days later, when the heavy rains had ceased.

Numbers of plots.	Top-dressings applied per acre.	Average Produce				Increase per acre.	
		Per plot.		Per acre.			
		Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
		LB.	LB.	LB.	LB.	LB.	LB.
3 + 7	None	76	1,442	183·9	3,489	..	..
1 + 5	Lime—1,742 lb.	90	1,487	217·8	3,598	33·9	109
2 + 6	Saltpetre—242 lb.	131	1,633	317·0	3,951	133·1	462
4 + 8	Gypsum—1,742 lb.	97	1,435	234·7	3,472	50·8	- 17

It will be seen that the two plots dressed with saltpetre produced nearly twice as much grain as the two plots of similar size that were not manured, while they also produced nearly one-fourth of a ton more straw. As the cost of the saltpetre applied was under 5 rupees per acre, it was more than recovered in the increase obtained. The increase from lime was not quite equal to the cost of the applications; but this was scarcely to be expected, as the action of lime is much slower, though more durable than the more active saline manures. The benefit from saltpetre will generally be obtained during the year in which it was applied, or at the outside in very dry seasons within the second year, whereas lime may act and give good results for ten years.

Another experiment, made in 1870, of a similar nature gave very interesting results. The crop selected was sorghum or Chinese sugar-cane; it had been sown on the 10th October in drills two feet apart

with seed at the rate of 14 lb. per acre; the plants came up slowly but with regularity, and the manure was spread when they were about 4 inches high on plots measuring one-eighteenth of an acre each, in duplicate. As usual, after sowing the top-dressings, a bullock-hoeing was given; the following are the average results.

Manure applied per plot.	Value.	Yield per plot		Increase per plot.		Increase per acre.		Value of increase per acre.	Profit per acre.
		Grain.	Straw.	Grain.	Straw.	Grain.	Straw.		
	RS	LB.	LB.	LB.	LB.	LB.	LB.	RS. A. P.	RS. A. P.
Unmanured	..	60	908	..	..	..	..	....	....
13 lb. of Peruvian guano	1	90	1,064	30	156	540	2,808	24 4 3	6 4 3
152 ,, of lime	1	99	1,237	39	329	702	5,922	36 9 10	18 9 10
10 ,, of saltpetre ..	1	110	1,318	50	410	900	7,380	46 7 6	28 7 6
37 ,, of bonedust ..	1	108	1,328	48	420	864	7,560	45 8 3	27 8 3
112 ,, of gypsum ..	1	96	1,181	36	273	648	4,914	32 9 1	14 9 1

In the above calculations the straw was valued at 5 rupees per ton, a low price; and the grain at the rate of 30 lb. per rupee, also a very low price.

It will be seen that saltpetre gave the best results; an expenditure of 18 rupees per acre on this manure having not only nearly doubled the crop, but, after repaying its own cost, left an additional farmer's profit of nearly 30 rupees per acre. The value of saltpetre has long been recognized in England; but its great cost in that country has prevented its general use; this salt is best applied as a top-dressing when the crop is a few inches above the ground: 100 lb. or at most 150 lb. per acre is enough to apply: it should always be mixed with sand or some similar material, in order that it may be more regularly distributed over the ground.

Bone dust stands second in the list; probably, if the continued effects of each were considered, it would stand first. Next comes lime (*chunam*); the expenditure of 18 rupees per acre not only being repaid by the increase in the crop, but a profit of nearly 20 rupees gained. Sulphate of lime (gypsum) comes next; this also not only repaid its original cost, but left profit of nearly 15 rupees per acre. The guano repaid its cost, but only left a profit of about 6 rupees per acre; it was inferior; still there were probably other reasons for the comparatively small return it gave.

In 1871 a portion of a field planted in alternate lines with New Orleans cotton and maize was top-dressed in the latter part of the first week in October, the crops at the time being only a few inches above ground. The land set apart for these experiments was divided into 16 plots, each containing one-twelfth of an acre. The experiments were repeated in duplicate. The whole of the land had been manured before the crop was sown with farm-yard manure at the rate of 20 cart-loads, or about 8 tons per acre. The following results are the averages of each pair of experimental plots over the two years during which the crop was kept down. The value of the top-dressings was Rs. 18 per acre.

Manure and top-dressing per acre.	Average yield per plot.				Average yield per acre.				Increase per acre.		
	First year.			Second year.	First year.			Second year.	Cotton in seed.	Maize.	
	Maize.		Cotton in seed.	Cotton in seed.	Maize.		Cotton in seed.	Cotton in seed.			
	Cobs.	Straw.			Cobs.	Straw.				Cobs.	Straw.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
8 tons farm-yard manure only	94	206	50·5	22·5	1,128	2,472	606	270	...	...	...
8 do. do. do. and 242 lb. guano ...	179	415	52·5	31·2	2,148	4,980	630	374·4	128·4	1,020	2,508
8 do. do. do. and 363 lb. saltpetre ...	147·5	365	55·5	29	1,770	4,380	666	348	130·3	642	1,908
8 do. do. do. and 605 lb. bone dust ...	161·5	345	52·3	26·6	1,938	4,140	627·6	319·2	63·1	810	1,668
8 do. do. do. and 605 lb. animal charcoal	126	244	66·1	25	1,512	2,928	793·2	300	217·2	384	456
8 do. do. do. and 2,758 lb. gypsum.	122	270	52·5	27·8	1,464	3,240	630	333·6	79·9	336	768
8 do. do. do. and 2,420 lb. bassia-nut cake	177	315	60	26·8	2,124	3,780	720	321·6	157·9	996	1,308
8 do. do. do. and 2,758 lb. lime ...	124·5	299	53·6	29·1	1,494	3,588	643·2	349·2	108·7	366	1,116

In 1877 a field of "Planter's friend" was selected for a series of top-dressing experiments; it had been sown on 28th September with seed by the drill at the rate of 22 lb. per acre, and the crop came up well; during the period of growth (106 days) 30·65 inches of rain fell on 32 days. On 12th October, in the centre portion of the field, 24 plots, each of one-twelfth acre in area, were marked down, 12 on the western and 12 on the eastern side; those on the east were denominated Series B, and in the first few plots a very sandy description of soil, differing greatly from the rest of the field, prevails; this is at the southern end. The soil on which the A series were situated is of far more even quality, and it is from them rather that reliable information can be derived. The top-dressings were all applied on the same day and immediately afterwards the bullock-hoes were put into the field in order to mix the manures with the soil and prevent their being washed away by any showers. On 14th October there was a slight fall of rain, ·2 inch, which was probably of great value in dissolving, whilst at the same time it did not wash out, the soluble manures; thus for the saltpetre and common salt applied the circumstances were as favorable as could be wished, but for the different applications of oil-cake, &c., probably it would have been more advantageous had the land been in a more saturated condition. Up to the 29th October none but very light showers fell, but during the total period of growth after the application of the manures 29·47 inches of rain were registered on 28 days. Shortly before harvest a few spots of rust appeared in the field, on the lighter soil generally first, and the grain was attacked by a fungoid disease; to this the deficiency of grain must be attributed. The results were as follow :—

Manure applied per acre.			Yield per plot.				Yield per acre.				Increase or decrease per acre.				Percentage of loss on drying straw for 17 days.
			A.		B.		A.		B.		A.		B.		
Weight.	Description.	Value.	Straw with ears.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	
LB.		RS.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	
...	Nothing	...	1,414	16¾	506	5¾	16,968	201	6,072	69	...	...	...	...	37
180	Saltpetre	12	1,918	23¼	784	9	23,016	279	9,408	108	+ 6,048	+ 78	+ 3,336	+ 39	28
90 372	Saltpetre ... ... White castor cake	12	1,524	23¾	980	8½	18,288	285	11,760	102	+ 1,320	+ 84	+ 5,688	+ 33	36
90 372	Saltpetre ... ... Bone charcoal	12	1,379	11¾	1,092	12	16,548	141	13,104	144	− 420	− 60	+ 7,032	+ 75	36
60 252 252	Saltpetre ... ... Bone charcoal ... ... White castor cake	12	1,792	8	1,148	9¼	21,504	96	13,776	111	+ 4,536	−105	+ 7,704	+ 42	37
90 189	Saltpetre ... ... Common salt	12	1,729	10	1,090	9¾	20,748	120	13,080	117	+ 3,780	− 81	+ 7,008	+ 48	21¼
378	Common salt	12	1,372	10¼	1,008	11¼	16,464	123	12,096	135	− 504	− 78	+ 6,024	+ 66	29¼
744	Bone charcoal	12	1,470	12¼	1,090	11	17,640	147	13,080	132	+ 672	− 54	+ 7,008	+ 63	30
372 426	Bone charcoal ... ... Old oil-cake, fresh	12	1,295	10¾	1,456	14½	15,540	129	17,472	174	− 1,428	− 72	+11,400	+105	36¾
372 426	Bone charcoal ... ... Old oil-cake, decomposed ...	12	1,480	12¾	1,568	10½	17,760	153	18,816	126	+ 792	− 48	+12,744	+ 57	37
744	White castor cake	12	1,624	10¾	1,176	17	19,488	129	14,112	204	+ 2,520	− 72	+ 8,040	+135	Not taken.
1,488	Castor seed husks	12	1,064	13¾	1,372	10¼	12,768	165	16,464	123	− 4,200	− 36	+10,392	+ 54	37

Looking at the A series alone, saltpetre gave by far the best results, the application being rather a heavy one. The lowest yield in the series was given where castor seed husks had been applied: this is not surprising considering the character of the manure, which, although it is probably very rich in ash constituents, from its nature will take a considerable time in decomposing. The white castor cake is composed of the kernel of the castor bean, and its value as a manure has already been referred to. These experiments seem to show that, for this crop on our land, common salt is not of much, if of any, value; mixed with saltpetre in equal values it did not yield as much as half the increase a full dressing of the saltpetre did, whilst when applied alone there was no increase observable.

The figures in the last column of the table show the percentage decrease on drying the straw, received from the several plots, in the open air for 17 days; they are the first of the sort recorded in India. It is well known that some manures induce plants to produce more succulent forage than others, and in estimating the value of fodder grown with different manures these characteristics must be taken into consideration.

In 1879, No. 8 field was set aside for conducting manuring experiments; it is about 2½ acres in extent, and was laid out with a view to making the experiments continuously over a series of years. It had been levelled some years before and has a surface fall of about 1 in 300, is fairly well drained, but surface water does not get off very rapidly. The soil is sandy, but of fair quality, easy to work, and not of too fine or too coarse a texture. Previous to the season of 1879-80 it was chiefly used for the growth of a variety of crops, and in December 1879 it was sown down with yellow cholum, which yielded in April 1880 a crop at the rate of 547 lb. of grain and 5,557 lb. of straw per acre. After this it was laid out in two divisions, each one acre in extent, with a roadway all round and between them. They were then sown at the end of June with horse-gram, which produced a very good crop, estimated at about 14,000 lb., and was ploughed in at the end of September as green manure. The field was cross-ploughed on 2nd October, and after this the two divisions (A on the north, B on the south) were each sub-divided into ten plots measuring one-tenth of an acre, the plots being two chains in length by half chain in width. Between each plot a pathway one and a half feet wide was left in order to mark them clearly, and to prevent, as far as possible, mixture of the soil of adjoining plots. The size and shape of the plots has been found convenient.

It was found in the season of 1881-82 that the experiments could only be continued on eight of the plots, those on the other plots having to be abandoned from the great want of uniformity in the soil, chiefly as regards its physical condition, drawbacks not disclosed fully until the long drought of that season. This is a matter for considerable regret as the results now available are not in duplicate, and therefore will need repeating once at least fully. The purpose of the experiments from the first was to compare the effects of the cattle manure, collected as before described, with manural substances that can be readily procured in the neighbourhood, in order to determine as nearly as possible the money value of the former. The application

of the purchased manures was limited in every case to five rupees worth per acre.

The following description of the cultivation for the first crop shows the care necessary in dealing with experiments of this sort:—

" On the 6th November each plot was ploughed (gathered) separately, and again on the 15th idem (split) after the application of manures. After harrowing down the furrows, white cholum (*Sorghum vulgare*) was sown across the plots in lines one foot apart. This crop was selected owing to the lateness of the season, but even it suffered considerably in point of outturn from being put in so late; it was first checked in growth by the extremely heavy rain at the end of November and beginning of December, and afterwards from the dry weather which set in. The field would have been sown earlier but the work of attending to the careful laying out of the plots and applying the manures was more than the state of Mr. Schiffmayer's health at the time allowed him to do. The crop appeared above ground on the 19th November very evenly over the whole field, but owing to the heavy rains mentioned above, part of that growing in plot A-10 died off from water lodging on the surface. This bed is a little too low and will require raising. As soon as the plants could be seen, those growing in the pathways between the plots were removed. The crop was twice bullock-hoed during December and once hand-hoed in January. During the latter month it made very little progress, and almost appeared as if it would fail, but recovered after the shower that fell on the 12th. During February it commenced to mature, but, so irregularly did it do this, that even by 16th March, when it was harvested, a considerable number of the ears were still unripe, whilst others were more than dead ripe. The straw was short and the sample of grain small; the latter weighed 2·9 lb. to a Madras measure (100 cubic inches)."

In the next season the plots were sown with yellow cholum on 7th September; the seed used was very good, 90 per cent. of it being vital grain. It germinated freely and produced a uniform covering of plants. The crop was harvested on 4th January 1882, and from the eight plots retained under experiment, the produce received was at the average rate of 770 lb. grain and 7,490 lb. straw per acre. After this harvest the weeds on each plot were examined with the following results:—

Plot	10	9	8	7
Manure applied ...	None.	Oil cake.	Cattle.	Lime.
Weeds { Number ...	Very few.	Few.	Overgrown with.	Very few.
Weeds { Varieties ...	*a, c, d, e.*	*b, c, a.*	*b, c, e.*	*a, c, d, e.*
Plot	6	5	4	3
Manure applied ...	Oil cake.	Ashes.	Cattle.	Cattle.
Weeds { Number ...	Few.	Few.	Very few.	Very few.
Weeds { Varieties ...	*b, c, f, g.*	*a, c, d, e.*	*a, c, d, e.*	*c, e.*

Names of weeds.	*Natural order.*
(*a*) Poa plumosa ...	Gramınaceæ.
(*b*) Cynodon dactylon ...	Do.
(*c*) Cyperus rotundus ...	Cyperaceæ.
(*d*) Ipomœa pestigridis.	Combretaceæ.
(*e*) Commelina Bengalensis.	Commelinaceæ.
(*f*) Eclipta erecta ...	Compositæ.
(*g*) Leuca Indica ...	Labiatæ.

It will be observed that oil cake encourages the growth of Hariali grass (*Cynodon dactylon*); a hint for grass growers.

The manner in which the plots retained were manured is shown in the table given below, and in the third season (1882-83) during which the experiments were continued no manure was applied. In that year the same crop was sown on 14th September, the seed being dressed in the usual way, and, germinating well, produced a fair stand of plant; but the crop suffered severely from unseasonable weather. The outturn from the eight plots was at the rate of 550 lb. of grain and 4,004 lb. of straw per acre.

The experiment was continued in the following season (1883-84) without manure, and ragi was sown. The crop was drilled in on 6th October in lines 9 inches apart, 12 lb. of seed being sown. Its early growth was checked by the weather experienced, and the and became very foul with weeds from the same cause. The crop was harvested on the 28th January and threshed out immediately; the weight of the grain is therefore proportionately high.

In the following table the yield of the plots is shown for the four years they have been dealt with; their area is one-tenth acre. It is almost useless to attempt to deduce anything from these figures, as they are not duplicated, and, even if they were, there is so much suspicion attaching to the original quality of the soil of the plots that deductions would be dangerous. The large outturn from plot 10 in the last year was probably due to its having received the wash off a piece of heavily manured land adjoining; otherwise it is inexplicable.

Plot.		Manures applied.	Outturn. 1880. Grain.	1880. Straw.	1881. Grain.	1881. Straw.	1882. Grain.	1882. Straw.	1883. Grain.	1883. Straw.	Total. Grain.	Total. Straw.
			LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
3	1880 1881-83	One ton farm-yard manure ... ... *Nil*	95	531	60	840	66	466	65	106	286	1,943
4	1880 1881 1882-83	*Nil* ... ... Half ton farm-yard manure ... ... *Nil*	54	291	99	672	55	454	91	100	299	1,517
5	1880 1881-83	2,860 lb. ashes ... ... *Nil*	51	238	84	840	65	458	93	136	293	1,672
6	1880 1881 1882-83	*Nil* ... ... 66½ lb. oil-cake ... ... *Nil*	57	281	75	840	66	421	98	154	296	1,696
7	1880 1881-83	211 lb. slacked lime ... ... *Nil*	48	210	61	728	48	328	45	88	202	1,354
8	1880 1881 1882-83	*Nil* ... ... One ton farm-yard manure ... ... *Nil*	47	218	99	896	53	370	65	122	264	1,606
9	1880 1881-83	50 lb. oil-cake ... ... *Nil*	84	361	80	616	50·2	342	64	150	278·2	1,469
10	1880-83	*Nil*	34	191	58	560	37	364	85	172	214	1,287
		Average ...	59	290	77	749	55	400	76	129	2,715	1,568

CHAPTER V.

CROPS AND CROPPING.

The chief objects of the Farm as regards crops are, it will be remembered, to ascertain the proper use of rotations in this country, to introduce a system of growing fodder crops, and the acclimatization of new crops of value for general purposes. The last-named object has of late been more especially confined in its earlier stages to the experimental grounds of the Agricultural College.

In order to ensure success in acclimatizing plants, they must receive more attention than can be bestowed upon crops when grown in the field. A plant grown from seed newly imported often meets with conditions differing greatly from those under which it grew formerly, and to which it has been accustomed: such plants must be carefully attended to; their growth must be carefully watched, and the minutest changes must be noted as indicating their wants and showing in what direction the treatment must be altered to aid their growth or to effect a cure. It is of the utmost importance in conducting experiments in the acclimatization of plants, &c., to secure the conditions most favorable for their growth and to eliminate everything that may cause any disturbance. It may perhaps be remarked that plants that require so much attention are of little agricultural value. It must, however, be remembered that plants of a high type, like animated beings, when placed under conditions much dissimilar to those they have been accustomed to, will suffer more or less, and that their organic structure must undergo a change and must adapt itself to new circumstances, and until this is effected the plant must go through a crisis, out of which it will pass triumphant if the conditions affecting its growth have not been too strongly opposed to its wants. Great care must consequently be taken to eliminate any disturbing elements, or the plant may fall a victim to circumstances that are uncongenial to its growth and to which it cannot accommodate itself. After a plant has once arrived at maturity under certain circumstances, there will be but little difficulty, with common care, in propagating the species, although most probably a new variety may be formed under altered climatic influences. Seeds of various plants have been obtained by gift and purchase from America, Queensland, Egypt, Java, China, and Italy, from time to time, and the results, together with those obtained in growing indigenous crops, will be found below.

Rotations.—At the foundation of almost every rational system of cropping will be found a more or less regular rotation of crops. Many benefits undoubtedly accrue from the adoption of a stringent rotation in cropping; still these advantages may be purchased at too high a cost. In a well cultivated district which is not subjected to any great atmospheric changes, but where the seasons recur with clock-work regularity and with perfect uniformity, it may be desirable to introduce a regular system of rotation. A properly arranged rotation of crops not

only enables the farmer to make the best use of the plant food in his soil, but also tends to conserve the fertility of it. One tribe of plants thrives and luxuriates upon food which may not only be useless, but even noxious to another; one delights in lime, another in phosphoric acid, a third in potash, and so on; or again, there are crops which require supplies of some particular plant food in such large amounts that they can only be grown successfully if grown seldom. Some plants have tap roots, some fibrous roots; some feed on the surface of the land, while others derive their sustenance from a lower stratum. Some plants are consumed by stock on the farm, and the excrements of the animals fed on them are again returned to the soil; while others are removed from the farm, none of the fertilizing matters they contain being returned to the soil. Some plants have narrow leaves and an upright habit of growth which encourages the growth of weeds; while others have broad leaves and throw out lateral branches which shade the ground and check the growth of weeds.

If a certain crop is cultivated year after year on the same piece of ground, it will ultimately remove such a quantity of the particular plant food it delights in as to render the raising of a remunerative crop of this particular plant a matter of great difficulty. It would be feasible to repeat the growth of any particular crop until its growth became unremunerative, and then to change the crop for a time and repeat the process, but for various reasons this is not so profitable nor so well advised as the adoption of a rotation. Granting that by careful manuring the elements of plant food taken up by any crop can be regularly returned to the soil, there are still many difficulties to contend against. It has been found that certain insects prey on particular crops, and that, if these crops are repeated too frequently, they increase to such an extent as to interfere very seriously with the profitable culture of these particular crops. Again, some plants—many of the leguminous family for example—have large fleshy roots, in which they store up a large amount of nitrogenous substances which they have elaborated from the ammoniacal matter they absorb; these roots, when left in the soil, decay and afford a large quantity of excellent food for other crops. This is well known in England, where a good clover crop—a crop producing plenty of fleshly roots—is invariably followed by a good crop of wheat, and here the cereal crop taken after a gram crop is generally a good one. Though a large crop of gram removes a good deal of lime from the soil, it is nevertheless considered by farmers as a restorative crop, and the reason just given explains this apparent paradox.

Again, it is the object of every agriculturist to economise labor, and, to do this efficiently, the seed-time must be extended over as long a period as possible. In temperate climates the seed-time extends throughout nearly the whole year. Here, owing to the character of the seasons, it is not possible to extend the seed-time very much; but to a certain extent it is, and, in constructing a rotation for any locality, the climate, having a most important part to play as regards the labor bill, must be carefully considered.

To a certain extent the practice of growing mixed crops, which prevails in a good many parts of the presidency, answers the purpose of a rotation.

As a rotation for dry lands applicable to many soils, including amongst the crops suggested two of the most valuable products commonly grown in Southern India, providing an adequate supply of food for man and beast, not presenting a system of exhaustive culture in too repeatedly growing the same crop or description of crop, and enabling the land to be kept free from weeds, the following may be suggested :—

First year—Corn crop and cotton.
Second do. —Indigo.
Third do. —Corn crop followed by a catch-crop of gram.
Fourth do. —Guinea grass.
Fifth do. — Do.

The only portions of the crops in such a rotation which should actually be sold off the land would be the cotton lint and indigo dye; the corn crop being used for the support of the cultivator, his family, and of such laborers as he employed, should not be lost, as the ordure and rubbish from their houses might be collected and returned to the land. The crop of Guinea grass would take the place of "waste" under native management.

On stiff strong rich soils, instead of planting Guinea grass in the fourth year, an early sown cholum crop, cut green for fodder, followed by a leguminous crop, such as black or green gram, could be taken, and, being harvested in the early part of the year, might be succeeded by a summer crop of gingelly; in the fifth year indigo might again be taken, followed in the sixth year by a corn crop, in the seventh and eighth years by Guinea grass. The rotation would then run as follows :—

First year—Corn and cotton.
Second do. —Indigo.
Third do. —Corn followed by gram as a summer crop.
Fourth do. —Cholum cut green, followed by a leguminous crop and by gingelly as a summer crop.
Fifth do. —Indigo.
Sixth do. —Cholum followed by gram as a catch crop.
Seventh and eighth years—Guinea grass.

Another variation might be made: instead of indigo in the fifth year, corn and cotton might be introduced, and another year added to the rotation, which would then become a nine-course one.

The Farm being devoted exclusively to experimental work, no fixed rotation of crops has been adopted, but the general principles referred to above are always held in view, and followed as near as circumstances permit.

Insect enemies—of crops are not common in ordinary seasons, but in 1877, after the great drought of 1876-77, there was a marked increase in the number of destructive insects found amongst our crops. At the time it was remarked :—

"Besides the excessive number of beetles, caterpillars, and locusts, on the crops generally, soon after our monsoon-sown paddy reached the height of about 6 inches a small greenish colored caterpillar, about 1—1½ inch in length, attacked it, devouring the extremities of the leaves to such an extent that the crops for a time were much checked and stunted in their growth. To what butterfly we are indebted for this pest I do not know. In order

to remove them, I endeavored by dusting over the field with lime early in the morning, whilst the dew was still on the plants, to drive them away; this was unsuccessful. After this I dried the beds where the caterpillars had appeared for several days, which caused the insects to drop off the plants, and after the subsequent watering no more annoyance from them was experienced."

The paddy crop was also attacked, when further advanced in growth, by a maggot of which, and the manner in which it works, the following extract is descriptive.

"A puncture mark was generally found in the stem between the upper node and the ear. On carefully splitting the stem, we frequently found the eggs of the insect lying inside immediately opposite the puncture mark; in other instances the maggot was found and nearly always solitary. This maggot is of a light yellow color, with dark-colored head; its length is about ·60 inch and its breadth about ·06 inch. It is, I think, the maggot of a dipterous fly closely allied to the *Chlorops lineata* or the *Cephus pygmæus*, both of which do great injury in Europe to standing cereal crops in the way some of the paddy crop has been damaged. In some of the culms we found the pupæ. The female fly apparently deposits its eggs in the stem of the plant, where they are hatched, and the maggots feed and enter into the pupa state. In some instances we found that the maggot had bored down through the node or joint in the straw, but such instances were exceptional. This would be, were it present in great numbers, a devastating insect, for, from its position inside the straw, it is perfectly unassailable to all ordinary endeavours to destroy it. I do not think that half per cent. of the culms even in those fields where it appeared were attacked, so that the loss caused in the shape of abortive ears was not very great."

The great disturbance of the ordinary climatic conditions which had been experienced during the two previous seasons was in all probability the chief cause of the abundance of insect pests, and therefore any more serious recurrence of them than there is in ordinary seasons is scarcely to be feared.

In 1879 almost all the cholum crops that had been attacked by rust were afterwards attacked by insects. The insect was a small fly which deposited its egg inside the covering leaves. The number of these flies increased so rapidly that in a few days the plants, which were first covered with rust, became whitened by the covering of insects. Degeneration of the sap was most probably the active cause of the insect attack. The insects attacked the straw only when it was nearly dry.

In the same year some of the tobacco grown on the Farm was also attacked by insects. In this case the pest was a small green beetle. The peculiarity of its attack was that it commenced its ravages on the bottom leaves where the stalk springs from the main stem, and from that place rapidly extended its attacks to the higher part of the bottom leaves, and, after having destroyed them, worked up the plant until the whole was ruined. The plants were covered by a black powder, which, when removed in the first stage of the attack, exhibited the leaf in its normal green state, but when left for a few days, caused the withering of the leaf. The plants that were raised from Farm-grown seed, which were acclimatized and appeared the most healthy and vigorous, were very little injured. This may be due to the fact that these plants were not so predisposed to attack on account of their vigor, or because they

were more advanced towards maturity and therefore contained more nicotin and consequently yielded a less palatable food for the insects.

FUNGOID DISEASES.—Very frequently crops of the different varieties of sorghum grown on the Farm have been attacked with both "rust" and "smut." These fungi appear to be developed only when the plants on which they grow have been subjected to sudden changes from cold to heat and from moisture to dryness, whether of the air or of the soil. Very bright dry weather commencing immediately after a long period of steady rain is especially productive of them.

The rust is probably closely allied to the corn-rust (*Trichobasis rubigo-vera*) which is common in damp districts in England, but is darker in color generally and varies from a bright to a purplish red. It generally appears first on the leaves of the plant and spreads into the stems, and when fully developed may be found to have penetrated them completely. The spores of the fungus probably exist in the soil, as its appearance has been noted on crops raised from perfectly fresh seed obtained from Bellary at the same time as it has shown itself on other crops grown from Farm-raised seed. The germs may have been brought to the soil with the manure, it being well-known that when straw that has been attacked by rust is used as cattle food or bedding, the parasite may be propagated by using the manure for cereal crops if the conditions affecting its growth are favorable. There appears to be no means for destroying the fungus, as dressing the seed is useless, for the spores of the fungus do not attack the grain. Once in the soil, they probably remain there a long time until they meet with circumstances favoring their development.

The smut consists of a conical distortion of the seed, of a greyish color externally; and when the covering is broken a cloud of fine black powder is dispersed. Cooke, in his Microscopic Fungi, thus describes the powder of the *Ustilago segetum* (corn smut), to which this smut bears a very close resemblance.

"This powder, minute as it is, every granule of it constitutes a spore or protospore capable of germination, and ultimately, after several intermediate stages, of reproducing a fungus like the parent of which it formed a part. During the growth of the plant, its virulent contents flow like a poison through the innermost tissues, and at length attack the peduncle or axis of the spikelets of the ear, raising up the essential organs and reducing them to a rudimentary state."

Unlike rust, the spores of this fungus may be destroyed by dressing the seed used with poisonous solutions, by which means those which have been mingled with the seed or are attached to it are killed. The process to be followed in doing this is as follows :—

"For 50 lb. of seed, take 3 ounces of sulphate of copper, which dissolve in one quart of hot water; when the solution is quite cold, pour it over the seed and mix thoroughly; when quite dry, the seed is fit for sowing."

Such a dressing is generally effective in preventing any attacks of smut in ordinary seasons; there is, however, another manifest advantage in dressing seed with sulphate of copper, and this is in preventing the coolies from eating the grain when they are sowing it. In other countries the loss in this way is too trivial to need attention,

but in this country, where four or five men are usually employed to do the work of one in other countries, and where the people are grain-feeders and frequently only half-fed, the consumption of grain during the sowing process often causes very serious loss, not so much on account of the value of the grain eaten as because the land is frequently only half seeded, a fact which is disclosed only when it is too late to remedy the evil.

It being well-known that when a very strong solution of sulphate of copper is used for dressing seed it decreases its vitality, an experiment was made to ascertain how far seed raised in this country is affected by different dressings. For this purpose American maize seed was used. The cobs from which the grain was obtained had been harvested before the end of March, and were dried for a few days before the experiment commenced. On the 2nd of April, at 9 A.M., 400 grammes (12·86 oz.) of seed were placed to steep in pure water; 400 grammes in water in which 2½ grammes (38·58 grs.) of sulphate of copper ($Cu.S.O_4$) had been dissolved; 400 grammes in water in which 5 grammes (77·16 grs.) of sulphate of copper had been dissolved; and 400 grammes in water in which 10 grammes (154·32 grs.) of the same salt had been dissolved. The seed was placed in vessels of the same size, and water was used in such an amount as to cover the seed about one inch deep. This water was poured off on the 3rd April at 3 P.M., and the seed was then left in the vessel and covered with moist blotting paper until the 6th of April at 3 P.M., when it was examined and the seeds that had sprouted counted. The following are the results:—

Sample.	Grains		Sprouted, per cent.	Remarks.
	Steeped.	Sprouted.		
No. 1.—In pure water.	1,305	1,172	89	Most of the germs from ½ to 1½ inch long.
No. 2.—In water in which 2½ grammes of $Cu.S.O_4$ had been dissolved.	1,260	872	68	Most of the germs from ⅛ to ⅛ of an inch long.
No. 3.—In water in which 5 grammes of $Cu.S.O_4$ had been dissolved.	1,445	497	34	Germs only appearing and looking sickly.
No. 4.—In water in which 10 grammes of $Cu.S.O_4$ had been dissolved.	1,274	212	16	Germs only appearing and looking dead; some of the germs being apparently destroyed by the strong solution in the act of appearing.

The results of this experiment show clearly that by using a large amount of sulphate of copper the vitality of the seed will be destroyed. If the result obtained with the sample steeped in pure water represents the normal vitality of the seed, then, in sample No. 2, 21 per

cent. of the vital seed was destroyed by the solution of copper. The dressing in this case was at the rate of 11·7 oz. of the salt per 100 lb. of grain. In practice the seed would scarcely be steeped for so long, and would soon be placed in the soil; where, especially if the latter were rich in lime, the loss of vitality would not be nearly so great. According to Kuhn, Dreish, and others who have made numerous experiments on this subject, not more than 5 oz. of sulphate of copper should be used per 100 lb. of grain, and even then the loss of vitality of some of the grains cannot be entirely prevented. Most probably some of the germs that appeared to be dead would revive again when put into the soil, and some grains that appeared to have no vitality might germinate under more favorable conditions, it being well known that seed that has been dressed with sulphate of copper germinates later than that which has not been, and also that those which are heavily dressed germinate more slowly than those to which only a light dressing is applied. It should, however, be remembered that the loss of vitality on the part of the less vigorous seed may be an advantage within certain limits in keeping sickly plants out of the crop.

Steeping is considered more effective than sprinkling, because, when the seed is steeped, the solution must penetrate into the grain and can then destroy such spores as are imbedded in the seed.

SEED SOWING.—Reference has already been made to the advisability of dressing all seeds before sowing them. It is also necessary that none but full, plump, well-formed and properly-matured seeds should be sown. They should be obtained from healthy and well-grown plants, and it is possible, by careful selection over a number of years, to cultivate varieties, and also to increase the productiveness of them greatly.

Before finally selecting the seed, its vitality should be tested; it may be done in the following way :—

"Take a shallow vessel—a soup plate will answer admirably;—place about an inch of good garden soil in the plate, and scatter over the soil 100 seeds; cover this with a piece of muslin, and over the muslin place about half an inch of soil. Keep the soil damp. After a few days the muslin with the upper soil may be lifted off and the condition of the seed ascertained. The number of seeds that have germinated will give the percentage of vital seeds. But it is better to make duplicate experiments and take the average of the results obtained as the percentage of vital grain. Ascertained in this way the results of the test are more trustworthy."

Having selected good seed and tested its vitality, dressed it to destroy fungoid germs and any immature grains that may be present, and having carefully cleaned it before to remove any seeds of weeds or of other crops, great care should be exercised in the method and time of sowing. The land must be well prepared by the means described in a previous chapter so as to obtain a fine, deep, moist and clean seed-bed. The fineness and depth necessary vary with different plants; cleanness is always necessary, as well as moisture. For most crops it is far the best to sow them in lines so that interculture may be performed with ease. The depth best suited for depositing seeds varies with every crop; but speaking generally, our large cereal grains,

e.g., cholum, should be covered about 1½ inch to 2 inches, and the smaller the seed the nearer the surface it should be sown; *e.g.*, indigo may be sown on a rolled surface and brush-harrowed in. When seeds are sown almost on the surface, as in the last case, the time for sowing is a most important matter. Two halves of a field, one sown in the afternoon and the other in the morning following, have been known to give most different returns, the former yielding a fair crop and the latter scarcely any plants. Probably the night moisture in the former plot was sufficient to start germination, and the day's sun in the latter to stop it almost entirely.

Experiments have been made in seed sowing at various times. In 1875, the following results were obtained with seeds of the varieties and with the percentage of vital grains named, sown at different depths in soil which had been dug to a depth of one foot and manured liberally with fold-yard manure and ashes. The seed was sown on the 21st of August at the different depths shown in the statement. One hundred grains of each variety were sown, except of the wheat, of which 200 grains were sown. Some of the maize seeds were destroyed by ants, hence the small number of maize plants. The wheat did not thrive; many plants perished, evidently from the unsuitability of the season. The beds were watered every third day. The ground was hoed on the 2nd September.

Counted.	Maize plants.						New Orleans Cotton plants.						Horse-gram plants.						Wheat plants.					
From seed sown at a depth of—	1 inch.	2 inches.	3 inches.	4 inches.	5 inches.	6 inches.	1 inch.	2 inches.	3 inches.	4 inches.	5 inches.	6 inches.	1 inch.	2 inches.	3 inches.	4 inches.	5 inches.	6 inches.	1 inch.	2 inches.	3 inches.	4 inches.	5 inches.	6 inches.
On 23rd August	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...
,, 24th do.	...	...	...	...	...	...	4	...	...	...	...	...	54	4	...	...	...	...	...	...	...	...	...	...
,, 25th do.	1	1	...	...	...	...	27	1	...	...	...	...	69	60	35	6	6	6	24	...	...	...	...	...
,, 26th do.	8	10	10	2	2	...	37	4	...	...	...	...	70	62	42	15	11	10	70	...	...	...	...	...
,, 27th do.	19	40	26	10	8	1	44	18	3	4	...	...	72	68	57	24	21	10	75	40	6	4	1	...
,, 28th do.	19	41	29	21	8	1	44	26	16	8	1	1	70	70	57	29	29	13	81	62	21	17	5	2
,, 30th do.	23	44	37	27	11	1	50	37	18	9	5	1	73	73	61	39	37	15	91	70	41	19	15	3
,, 31st do.	23	44	37	27	11	1	50	37	18	9	5	1	73	73	61	40	38	17	91	70	41	20	15	6
,, 1st September	23	44	37	27	11	1	50	37	18	10	5	1	73	73	61	40	38	17	91	70	41	20	15	5
,, 2nd do.	23	44	37	27	11	1	50	37	18	10	5	1	74	75	61	40	38	17	91	70	41	20	15	5
,, 3rd do.	21	41	34	27	11	1	48	34	17	10	5	1	69	72	58	38	33	16	74	68	41	20	15	5

It will be observed that the maize seed gave the best results when sown at 2 inches in depth. When maize is sown at any greater depth than 4 inches, the crop, from deficiency of plants, must be a failure. It will be noted that, when the seed was sown 2 inches deep, most of the plants appeared above ground five days after the seed was sown. With the cotton seed, the best results both as regards number of plants and early appearance above ground, were obtained when the seed was deposited only 1 inch deep, and it will be observed that the cotton seed is even less able than the maize seed to produce plants when sown at depths greater than 3 inches. Of the seeds tested, horsegram appears to be the least affected by differences in the depth at which it is sown; it is remarkable for its rapidity of germination, and equally so for its ability to produce plants when sown at a considerable depth in the soil. With wheat, the best results were obtained with sowings at 1 inch in depth.

From these experiments it would appear that the greatest number of plants is obtained from seed sown at depths of from 1 to 2 inches. It must, however, be remembered that the ground on which the seed was sown was watered every third day, and that it had previously been dug over to a depth of 1 foot and was liberally manured.

In 1879 another set of experiments was instituted with yellow cholum to investigate the effect of deep and shallow sowing. For this purpose three beds were sown on the 19th of October. The soil of the beds was uniform and their preparation alike. In one bed the seed was placed 1 inch, in the second 3 inches, and in the third 5 inches deep. The seed in all the beds germinated very well and the plants grew with uniform vigor until about 2 feet high, when the plants growing from the seed sown 1 inch deep commenced to suffer from the effects of the powerful sun prevailing at that time, and were soon afterwards so severely attacked by rust that it appeared as though every function of life were extinct. The plants raised from the seed deposited 3 inches deep were but little attacked by rust, and those raised from seed sown 5 inches deep were nearly free from the disease. Soon after the rust appeared, the beds on which the cholum was growing were watered every day to thoroughly soak the soil. This was continued for about a week, when it was observed that the cholum, that was stunted, had revived again and was making a fresh start; it afterwards attained nearly the same height as that in the other beds. The rust, which had covered nearly the whole plants at the middle of November, had almost entirely disappeared a month later. The crop was cut on the 3rd of February 1879. The following table shows the weight of green fodder received from each bed :—

Bed.	Treatment of seed.	Yield per plot.	Yield per acre.
		LB.	LB.
C 5 ...	Sown 1 inch deep	252	16,940
C 4 ...	Do. 3 inches deep	208	18,823
C 3 ...	Do. 5 inches deep	368	24,737

The results of this experiment are very instructive. They show clearly that the plants only suffer from this disease (rust) when they are weakened and the functions of life are paralyzed by adverse conditions, and that they can recover their vigor if the principal cause of the disturbance is either removed or its effects neutralized at the proper time. Owing to the fact that the roots of the plants sown shallow would be more confined to the surface than those of the plants sown deep, through the temperature of the surface soil being raised by the direct action of the sun, the roots of the former were exposed to inimical circumstances which probably were so powerful as to impair the exercise of their functions of preparing and conducting food to the other parts of the plants, and thus caused debility in the whole plant, and nullified its power of resisting the attacks of disease. The results of this experiment differ from those made with crops grown under dry cultivation, related above; in some of which the seed sown at 5 inches deep failed to germinate. This apparent contradiction may be attributed to the differing conditions of the soils experimented with, and illustrates the necessity for repeating such experiments under as great a variety of circumstances as possible before attempting to draw general deductions.

In the same year a set of field experiments were made to as certain the best distance apart at which to sow the same crop; and the results are given below.

Number.	Seed sown in lines.	Outturn.			
		Average of 2 plots.		Per acre.	
		Grain.	Straw.	Grain.	Straw.
		LB.	LB.	LB.	LB.
1	9 inches apart	67	1,461	322	6,957
2	12 do.	69	1,278	328	6,085
3	18 do.	61	1,404	294	6,686
4	24 do.	63	1,274	303	6,086
5	Alternately 6 inches and 18 inches apart ...	64	1,265	305	6,026
6	Broadcast	26	1,040	123	4,952

In every case the plots were duplicated; the average outturn is given, and by this means errors likely to creep in from the varied nature of the soils of the field are in a measure neutralized. The area of the plots was ·21 acre. The figures tend to show that it is best on our soils to sow this crop in lines about 12 inches apart; at which distance the highest yield of grain was obtained. The relative values of the crops obtained per acre from Nos. 1, 2, and 3 were as follow :—

——	No. 1.			No. 2.			No. 3.		
	RS.	A.	P.	RS.	A.	P.	RS.	A.	P.
Grain	10	11	9	10	14	11	9	12	10
Straw	23	3	0	20	4	6	22	4	7

From this it will be seen that the most valuable crop was most closely sown. It is, however, necessary to note that the duplicate plots presented great variance, and, in the case of one plot sown in lines alternately 18 and 6 inches apart, the highest yield of grain of all was obtained. Most striking, however, is the clear demonstration of the inadvisability of sowing such a crop broadcast. On the broadcast plot the yield of grain was scarcely more than one-third and that of straw a little more than two-thirds only of the yield from plot No. 1. The cost of hoeing the crop was also much greater in the case of this plot, as it all had to be done by manual labor. The value of the whole crop per acre in this case was only Rs. 20-12-8.

A further experiment was made in the botanical grounds in the same year on a small scale with the same object. Three beds were divided into ridges of equal sizes. In one bed two lines were sown on each ridge, in the second bed three, and in the third four lines. The soil of all the beds was similar and the ridges were of equal size. The seed, which had been steeped in lime water, was sown in equal amounts in all the beds on 19th October; it germinated well and the plants grew uniformly and vigorously. The crop was cut on the 28th of January with the following results:—

Bed.	Number of lines sown on each ridge.	Yield.	Yield per acre.
		LB.	LB.
A 1 ...	Two	448	30,116
A 2 ...	Three	481	32,334
A 3 ...	Four	504	33,981

It will be noted that the yield was heaviest where four lines had been sown on each ridge, and where, consequently, the lines were closer. This is in accordance with general experience. Fodder raised in this manner is also usually more tender and juicy, and therefore both better food for, and more palatable to, live stock.

In 1882 an experiment was made in field No. 15 in thick and thin sowing. Two plots were selected, each of one acre in extent, and each was sown with yellow cholum—plot No. 1 at the rate of 25 lb. per acre, and No. 2 at the rate of 53 lb. per acre. The following statement gives the results:—

Plot.	Area.	Crop.	Date of sowing.	Amount of seed used.	Date of harvest.	Outturn.	
						Grain.	Straw.
			1882.	LB.	1883.	LB.	LB.
I	One acre.	Yellow cholum ...	7th Sept.	25	5th Jan.	214	8,466
II	Do. ...	Do. ...	Do.	53	6th Jan.	151	11,217

A drought in September was very injurious tó the crops, and they never recovered fully from its effects. The yield of grain was greatest on the thinly-sown plot, but the thickly-sown plot gave a much larger yield of straw.

EARLY HARVESTING.—A point which is not understood by the cultivators of this country is the imperative importance of harvesting crops before they are dead ripe. On this point the following experiment is instructive:—A small plot of car paddy, containing 388 square yards, was divided into two equal parts: one-half was harvested when the grain, on being pressed between the finger and thumb, ceased to exude any milky fluid, though the straw at the time was quite geeen; the other half was allowed to stand until dead ripe, as is the usual practice of the ryot. The first half was cut on the 13th June and the other on the 3rd of July. The following are the results:—

Plot.	Area.	Produce per plot.		Produce per acre.	
		Grain.	Straw.	Grain.	Straw.
	SQ. YDS.	LB.	LB.	LB.	LB.
No. 1 cut early ...	194	56	245	1,397	6,112
No. 2 cut late ...	194	42	170	1,047	4,241

Thus, the plot early harvested produced per acre 350 lb. more grain and 1,871 lb. more straw than the half that was allowed to stand until it was dead ripe. Any one conversant with the appearance of paddy land a few weeks áfter harvest will readily account for this loss of 350 lb. of grain. It is chiefly shed on the ground, though a certain proportion is carried off by birds. The difference in the weight of the straw was due to the larger quantity of juice it contained when cut green, and, as at this stage in the growth of the plant its juice contains a large percentage of nutritive matters, this increased weight is so much gain; besides, a ton of straw cut when dead ripe does not contain so much nutritive matter as an equal weight cut two or three weeks before it has reached this stage. The results of this experiment fully agree with the experience of European countries.

It has, in fact, been found that paddy may be safely harvested, as far as the yield and quality of grain produced is concerned, whilst the corn is still green; it must, however, be dry, not exuding any milk on pressure or rupture, and, if so, will gain its proper color after it is threshed, or better still on the straw; whilst by cutting early, little or no loss from shedding will ever be experienced. With most other crops the same experience holds good.

CROPS EXPERIMENTED WITH.—The following is a list of the crops referred to below in detail, which have from time to time been variously experimented with on the Farm, but it must be remembered, in reading these references, that the nature of the soil of the Farm is exceptional as will be seen by turning to the first chapter.

Botanical name.	English or common name under which crop is referred to.	Tamil name.	Telugu name.	Hindustani name.
Triticum vulgare and Triticum spelta.	Wheat.	Godumay.	Godumalu.	Gehun.
Zea Mays	Maize.	Makka-cholum.	Mokka-jonna	Mokka-boota.
Sorghum vulgare ...	Cholum or Great millet.	Cholum.	Jonna.	Jcar.
Sorghum saccharatum	Chinese sugar-cane.	...	...	...
Do. ...	Early amber sugar-cane.	...	...	...
Sorghum Kaffrarium.	Imphee and Planter's friend.	...	...	...
Saccharatum officinarum.	Sugar-cane.	Karumboo.	Cherukoo.	Gunna.
Penicillaria spicata ...	Cumboo or Spiked millet.	Cumboo.	Sujjaloo.	Bajree.
Eleusine coracana ...	Raggi.	Kelvaragoo.	Ragooloo.	Ragee.
Panicum Italicum ...	Italian millet.	Tennai.	Koraloo.	Kora.
Panicum miliare ...	Little millet	Samai.	Shamaloo.	Kungoo.
Panicum miliaceum ...	Common millet.	Varagoo.	Varagalu.	Chenna.
Oryza sativa ...	Paddy.	Nelloo.	Vadloo.	Pusuel.
......	Fodder crops and Grasses.	...	...	...
Dolichos uniflorus ...	Horsegram.	Kolloo.	Woola-waloo.	Koaltee.
Cicer arietinum ...	Bengal-gram.	Kadalay.	Sanegaloo.	Chenna.
......	Other pulses.	...	...	...
Glycine Soja ...	Soy beans.	...	...	...
Indigofera tinctoria ...	Indigo.	Averie.	Neelee.	Neel.
Nicotiana tabacum ...	Tobacco.	Pogha-iley.	Poghaku.	Tambaku.
Ricinus communis ...	Castor-oil plant.	Sittamunak.	Sittamindi.	Arend.
Sesamum Indicum ...	Gingelly-oil plant.	Yelloo.	Noowooloo.	Kapas.
Arachis hypogæa ...	Ground-nut.	Verkadalai.	Nela sanagalu.	Moong-phullie.
Gossypium (var.) ..	Cotton.	Paratie.	Puttie.	Ruyee.
Hibiscus cannabinus...	Roselle.	Pulichey-kiray.	Yerra-gogu.	Kaserica.
Crotalaria juncea ...	Sunn hemp.	Jannappa	Shanamoo.	Sunn.
Corchorus olitorius, Do. capsularis.	Jute.	Parinty.	...	Singin janascha.
Bœhmeria nivea ...	Rhea or China grass.	...	...	...
......	Other fibres.	...	...	...
Musa textilis ...	Manilla hemp.	...	...	...
Musa paradisiaca ...	Plantain.	Valai.	Ariti.	Mauz.
......	Miscellaneous and garden crops.	...	...	...

WHEAT—has been experimented with on several occasions, but always with a like indifferent success, pointing to the unsuitability of the soil and climate for the crop.

In 1875 several small plots were sown with wheat; some with seed obtained from the Nilgiris and others with seed produced in the Coimbatore District. The sowings were made at different dates between the 1st of January and the middle of March. The seed from both districts germinated well and produced vigorous and healthy plants; however, only a very small proportion of them succeeded in maturing any grain, the result evidently of the high temperature that prevailed during the latter half of their growth. The experimental plots were all thoroughly cultivated and liberally manured, and irrigation water was applied when necessary. The species experimented with in this case was the *Triticum spelta.*

In 1876 two samples of wheat were obtained from Egypt and sown, but though they germinated and grew fairly at first, no grain was produced; this may have been owing to a want of sufficient water, to a higher temperature than is usual in Egypt, and to the lightness of the soil on which the crop was sown.

In 1877 some further experiments were made with seed obtained from Agra, but the results were very similar to those already given; the crop was, however, sown in October and harvested in January. The varieties sown in this case were both red and white native wheat.

Again in 1878 two samples of common wheat, one red and the other white, were received from the North-West Provinces; samples were also obtained from Bellary and Kurnool, and of spelt wheat from Cuddapah and Salem. On the 3rd of October a small plot was sown with each of these six samples; all germinated well, but the plants raised from Salem spelt wheat and Bellary wheat suffered from the commencement and died within three weeks after they appeared above ground. The plants also of the red wheat received from the North-West Provinces grew well at first, but commenced to wither within about five weeks after their appearance above ground. The plants of the remaining varieties grew very well at first, but were checked in the latter part of November; reviving, however, again in December they grew very vigorously afterwards, and attained a height of about 2 to 2½ feet. They flowered in the middle of January and the crop was harvested in the middle of February. The outturn of grain was very small, most of the ears being empty. This was the first time that wheat had ever been cultivated here with any success, and had it not been for an exceptionally bad season the yield of grain would have been much better. A somewhat stiffer soil than that used would probably also have increased the outturn.

In 1881 another small plot sown with common wheat also failed to give good results. Again, in December 1883 some samples of wheat received from the Punjab were sown in the Botanical Gardens in plots of 80 square yards each, when—

Red wheat gave 4½ lb. grain and 52 lb. straw.
White wheat gave 2½ lb. grain and 44 lb. straw.

The former weighed 2 lb. 13 oz. per Madras measure and the latter 2 lb. 10 oz. The soil of the plots is artificial but sandy, and the crops were treated as garden crops. This is the most successful experiment made at Saidápet in wheat growing.

MAIZE—has become a regular crop on the Farm, occupying an important place as one of the best food crops we possess. It however requires better cultivation than that generally practised in Southern India, and so when good seed falls into the hands of native cultivators its fate is inevitable and it rapidly deteriorates. It has been found that one average-sized Queensland maize cob grown under good cultivation at Saidápet yields more grain than 1 of the cobs grown near Vellore. The value of the grain for human food is well known, excelling by far rice and the dry grains of this country, whilst at the same time it is more productive, and will thus support a larger population. On good soils 2,000 lb. of grain may be grown per acre without extraordinary management, and at the same time from 2½ to

3 tons of dry straw per acre may be expected: this straw is rich in saccharine matters and is a valuable fodder for all kinds of farm stock. The crop, however, should be well manured with organic manures, and will repay the application of very heavy dressings. It is admirably adapted for growing in the intermediate spaces left in cotton cultivation, as it occupies the ground only about four months, and when removed leaves the cotton plants as a crop on the land for the hot weather, the usual objection of the unprofitableness of cotton culture being thus obviated; the maize crop paying at least all expenses, and leaving the cotton, which is sold, for profit.

The seed in this country very soon loses its vitality, and is usually severely attacked by insects in the granary, so some experiments were made in 1882 to ascertain the effect of different dressings and admixtures on the vitality of the seed. Eight samples of maize, each weighing 26 lb., were placed in kerosine oil drums with the dressings, &c., mentioned below, and the drums then made air-tight. They remained thus on a dry shelf in the granary from May till October when they were opened and the vitality tested. The results were as follow:—

Number.	Dressing or admixtures with seed.	Vitality of seed in Oct.
		per cent.
1	Ten measures of maize, weighing 26 lb., dressed with a mixture of one-eighth ollock of tar and three ollocks of water	71
2	Do. mixed with quarter ollock of tar and 5 ollocks of water	46
3	Do. do. with 6 lb. of wood-ashes ...	50
4	Do. do. with 6 lb. of slaked lime ...	84
5	Do. do. with 6 lb. of quicklime ...	56
6	Do. dressed with 1 oz. of sulphate of copper	60
7	Do. do. with 2 oz. of sulphate of copper	68
8	Do. without dressing or admixture ...	85

From these results it would appear that the different dressings and admixtures used were injurious to the seed, but the experiments were not fully carried out; they should have been made in duplicate, and one lot of grain have been exposed freely to the attacks of insects. We have yet to ascertain how far the dressings and admixtures protect grain from the attacks of weevils, &c. It was certainly surprising that maize stored nearly six months in a hermetically-sealed iron vessel should have shown a vitality of 85 per cent. It is difficult to understand the low percentage of vitality of the grain mixed with wood-ashes, unless the admixture made the seed too dry; wood-ashes being frequently mixed with seed for storing. All the grain was thoroughly dried before being stored.

It is advisable to tar the seed before sowing to prevent it from being carried away by crows, squirrels, or rats, or from being eaten by the coolies when engaged in sowing; the process followed in preparing the seed being as follows:—

"Take one and a-half pints (about half a Madras measure) of hot water and add about one-twelfth of a pint (about one-fourth of an ollock) of tar; stir well together. After allowing the solution to cool, pour it over about

twenty measures of maize; mix together until the seed assumes a dark mahogany color, and then dust it with sand, saw-dust, or dry earth, to prevent the seeds adhering together."

The seed may be sown on the flat or on ridges. If the crop be taken alone, in rows about 3 feet or more apart, according to the condition of the soil, at the rate of 30 lb. per acre; if grown with cotton, it may be sown rather further apart and in alternate lines with the cotton crop.

In harvesting, the cobs should be well matured before being gathered. If the weather during the time be favorable, the skins are best kept on the cobs until the seeds are perfectly hardened and glazed.

In the following table the results of some experiments made in 1869 with this crop are given. The seed was sown on ridges 3 feet apart, and box-manure had been applied to plot 1 at the rate of 25 tons per acre; to plot 2 at the rate of 15 tons; and to plot 3 at the rate of 20 tons. To plot 1, in addition, 2 cwt. of bone dust was applied. No manure was applied to plot 4, the soil being in good condition, having carried no grain-crop since it had been reclaimed.

Plot.	Area in yards.	Date of sowing.	Seed sown.	Seed sown per acre.	Duration of growth.	Rainfall.	Wet days.	Yield of fresh cobs.		Yield of grain (dry)		Yield of straw (dry).	
								Actual.	Per acre.	Actual.	Per acre.	Actual.	Per acre.
			LB.	LB.	DAYS.	IN.		LB.	LB.	LB.	LB.	LB.	LB.
1	5,774	Oct. 12th	36	30	97	20·89	40	7,080	5,934	1,851	1,551	7,456	6,250
2	10,647	„ 18th	54	25	91	20·16	37	7,382	3,355	1,877	854	8,411	3,823
3	6,044	„ 31st	40	32	78	18·17	32	1,932	1,547	1,063	851	7,271	5,822
4	4,918	„ 26th	27	26	83	19·94	36	2,366	2,328	850	836	7,665	7,543

After allowing for all expenses, the profit per acre was—

	RS.	A.	P.
Plot 1	28	12	3
„ 2	15	1	0
„ 3	20	11	0
„ 4	38	6	2

A storm occurred on the 16th of January 1870, and it was necessary to begin harvesting next day. The yield of grain from plots 1 and 2 would have been much greater had not the effects of the storm necessitated the harvesting of the crop before it was matured. In forming any conclusion on the results of these experiments, the wretched nature of the soil must not be lost sight of. Not only is it very poor in the elements of plant-food, but it is physically a bad soil. It parts with its moisture too rapidly, and during hot weather becomes very hard and compact. However, if such soils—and there is a large area of similar soils in an uncultivated state in this district—will under maize give a profit of 25 rupees per acre, that obtainable on good soils must be large.

A comparative experiment in growing maize and cotton on the "hill" system and on the "ridge" system was made in a field which was divided into two plots each measuring about 1¾ acre. On the eastern plot the seed was sown on hills 2 feet apart each way. Two lines of hills were sown with maize, and two lines of hills with

cotton-seed alternately throughout the field. The western plot was ridged 2 feet apart, and the seed was sown on the ridges, two lines of maize alternately with two lines of cotton, throughout the whole area. The outturn was as below :—

—	Cobs.	Straw.
	LB.	LB.
Hill system—East plot ...	1,830	7,728
Ridge do. —West plot ...	1,556	7,294

The following are the results obtained with a sowing made out of the usual season—September—under occasional irrigation, and are worthy of notice, for maize being a tall growing plant is liable to injury by the high winds of the north-east monsoon. A plot of land measuring 1,950 square yards was, on the 15th of January 1875, sown with 14½ lb. of maize seed. The soil is a free sandy loam; it was twice ploughed, twice harrowed, manured with 1,500 lb. of oil-cake and 14 cart-loads of ashes, and ridged. During the growth of the crop the land was irrigated five times and once hand-hoed. The plants grew so luxuriantly that it was found necessary to thin out a considerable number; the weight of fodder thus obtained was 1,134 lb. The remainder of the plants matured three months after sowing, and produced 1,738 cobs and 1,324 lb. of dry straw. The cobs were small from the plants having been too crowded on the ground: the total yield of cobs was 4,314 per acre.

In 1877 seeds of ten varieties of maize were received from Italy; sown in June, germinated well, but did not succeed as a crop. The plants reached a height of about 6 feet, but only matured a few small cobs, and even the seed thus obtained did not succeed or produce plants and cobs as fine as Australian maize. In this case an interesting phenomenon was observed on one of the plants. The male part of the flower instead of being separated from the female was connected with it and remained in this position until the cob attained maturity. Generally the male flower crowns the plant, the female being situated part way down the stem.

In 1881, from a sowing of 80·5 lb. of Australian seed on 3·56 acres of land, 3,378 lb. of grain and 24,595 lb. of straw were obtained.

"The crop was sown on the 13th and 15th September, but during November a considerable portion of the crop was in flower when the heavy rains set in or the outturn would have been a heavy one; as it was, the yield was good, considering the nature of the soil on which the crops were grown. Plot A of Field No. 15 gave an outturn of 5,673 cobs per acre, which yielded 1,042 lb. of maize, while Field No. 11 gave an outturn of 4,027 cobs per acre, which yielded 818 lb. of grain; and the yield of straw in both cases was good. The straw was remarkably sweet, and had it been crushed when the cobs were gathered, a considerable quantity of jaggery might have been made from the juice. However, this saccharine matter was not wasted, for it greatly added to the value of the straw when used for feeding the cattle. The plot of maize produced in the experimental grounds also yielded well; the outturn was 1,073 lb. of grain and 5,354 lb. of straw per acre."

The crop is one worthy of much attention in this country. Without the aid of irrigation water, on the poor soils of the Farm, good tillage and the moderate use of manure secured in the above experiment the production of an average outturn of 984 lb. of grain and 6,270 lb. of straw per acre. Valuing the grain at 30 lb. per rupee and the straw at Rs. 8 per ton—prices readily obtainable—the crop was worth Rs. 55-3-1 per acre, while the expenses incurred on tillage, manure, and harvesting amounted to not more than Rs. 30 per acre. Unfortunately, the greater portion of the Farm is too sandy for the production of maize; the soil does not afford the plants anchorage, and thus they fall down when the ground becomes saturated if there is any wind.

It is surprising that maize has not yet received any attention in this country for the production of malt for use in brewing; barley is so difficult to obtain, and is always so very inferior.

A portion of the straw from the experimental plot referred to above was crushed in December 1881, when the cobs were gathered, and from the juice obtained jaggery was made. The following is an account of the experiment:—

Number of experiment.	Variety used.	Canes taken.			Yield of juice.			Yield of jaggery.		
		Number.	Total weight.	Weight after stripping and topping.	Volume.	Weight.	Per cent. of cane.	Weight.	Per cent. of juice.	Per cent. of cane.
			LB.	LB.	C.IN.	LB.		LB.		
1	Hawkesbury River ...	100	80	54	500	21	26·25	2·25	10·7	2·81
2	Do. ...	200	175	112	1,050	43½	24·85	5·50	12·6	3·14
3	Clarence River ...	100	94	63	525	21½	22·87	2·50	11·6	2·66
4	Do. ...	100	95	64	575	25	26·31	3·25	13·0	3·42

It will be observed that the yield of jaggery on the average was about 3 per cent. of the weight of the straw. Mr. Hamilton, F.C.S., was good enough to make an analysis of the jaggery produced. The following is his report:—

—	Clarence river maize.		Hawkesbury river maize.	
	Manured with.		Manured with.	
	Oil-cake.	Oil-cake and gypsum.	Oil-cake.	Oil-cake and gypsum.
	1	2	3	4
	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Crystallizable sugar	34·99	29·61	28·93	31·40
Non-crystallizable sugar ...	11·46	25·22	17·19	18·34

"The large amount of water in Nos. 1 and 3 will account for the smaller quantity of total saccharine matter. None of the samples have the consistence of jaggery; they are syrups of varying density, Nos. 2 and 4 being more concentrated. The higher percentage of non-crystallizable sugar in No. 2 points to some defect in preparation—either that the juice was not immediately boiled, or that the prolonged boiling of maize juice in open pans favors the conversion of the crystallizable sugar into glucose."

It will be seen that the jaggery from the "Clarence river maize" was richer in crystallizable sugar than that of the other variety. It is difficult to explain why the gypsum-manured portion yielded a smaller percentage of crystallizable sugar, for it is generally supposed that gypsum facilitates the formation of this kind of sugar. However, on both plots, gypsum considerably increased the total yield of sugar. In the case of the "Clarence maize" the increase was nearly 10 per cent. As far as the data afforded by these experiments enable an opinion to be formed, it does not appear that it will pay to make jaggery from the juice of the maize plant unless it be grown on soils much superior to those on the Farm. The subject, however, is one well worth further investigation both here and elsewhere.

Maize may be grown with success as a fodder crop. In the season 1876-77 a plot measuring 2,418 square yards was sown with this crop; and, under occasional irrigation, produced, between 8th November and 6th February, 6,108 lb. of fodder, which is at the rate of 12,226 lb. per acre. The rainfall during the period of the growth of this crop was 3·90 inches, and the crop received eight waterings; it was manured with about twelve loads of stable manure, and received a top-dressing of 50 lb. of saltpetre. Thus it produces a fair crop of fodder; this fodder is highly prized in America as a food for milch cows. The presence of a large quantity of sugar in the straw of maize indicates the high value of it for feeding stock.

Cholum or Great Millet—is one of the cereals most extensively grown on the Farm both for grain and for fodder. There are several varieties of the plant differing in scarcely any degree except in the color of the seed; they are white, black, red, and, chief of all, yellow-seeded. The latter is the most important.

Yellow Cholum—has two varieties, one close-headed and the other open-headed like the *Sorghum saccharatum*; the latter is preferable as it ripens more freely and moisture cannot so easily lodge in the ears and so injure the grain. The crop has been largely grown both for grain and for fodder; in the latter respect it has scarcely a rival. It can be grown on all classes of soil with success, but no doubt deep strong soils are best adapted for it. For success, it must be sown on a well-prepared, deeply-tilled, and adequately-manured soil. If to be grown under irrigation, it is best to sow the seed on the ridge, the seed being thinly sown at the rate of 20 to 30 lb. per acre only; if intended for fodder, it should be cut when two-thirds grown, and will, under irrigation, yield as far as 50,000 to 70,000 lb. of fodder per acre in a year; whilst, if unirrigated, during seven or eight months it will produce four cuttings, yielding about one-third of that amount. If grown for grain, it will produce from 500 to 1,000 lb. of seed, besides 4,000 to 6,000 lb. of good straw per acre. Under spade-culture in the Botanical Garden, on small areas of about 72 square

yards, crops yielding at the rate of from 70,000 to 90,000 lb. per acre in one cutting have been grown; this shows that the crop amply repays high culture, and also what could be done by every ryot for the production of forage for his live stock.

White Cholum—in a great measure possesses the qualities of the yellow variety, to which it is closely allied, and from which it differs chiefly in the color of the seed and the character of the panicle. It has not been experimented with so largely; however, as far as experiments have gone, the results have not been so satisfactory as those attending the cultivation of yellow cholum.

Black Cholum—is a variety grown to a considerable extent on the poorest soils in the Trichinopoly District. In general appearance the plant closely resembles the *Sorghum saccharatum*, but in the seed the husk does not adhere nearly so closely to the grain; it moreover contains little saccharine juice. The following statement of the botanical characters of the two plants shows that they are not identical.

—	Indigenous. *Sorghum vulgare* (Black cholum).	Introduced. *Sorghum saccharatum* (Chinese sugar-cane).
Panicle	Branches not strictly verticellate (sub-verticelled).	Branches drooping, verticelled.
Calyx of hermaphrodite flowers.	Valve black and shining, back smooth. White cilia round the margins.	Less black, not shining. Both valves hairy.
Corolla of hermaphrodite flowers.	One of the valves awned.	One valve awned. The specimen sent therefore is the *Holcus saccharatus* of Linnæus, and not the *Holcus saccharatus* described by Roxburgh, the corolla of which has no awn.
Calyx of neuter flower.	2 valved	1 valved.
Stem	Single, smooth, round. Less thick than stem of *Sorghum saccharatum*.	Jointed, sometimes ramous, thicker than stem of the black cholum.

The crop yields heavily in grain; in fact the heaviest outturn of any cholum crop recorded on the Farm was from one of this variety in the year 1879-80, when in 124 days, from seed sown at the rate of 18 lb. per acre, 1,265 lb. of grain and 8,189 lb. of straw per acre were obtained. That it is capable of producing heavy crops of fodder was also shown on two beds sown on 11th June 1879 in the botanical grounds with Trichinopoly seed. The average outturn per acre was over 48,000 lb.; Chinese sugarcane raised at the same time and under similar conditions producing less than 41,000 lb. per acre.

Red Cholum—is another variety of *Sorghum vulgare* and has only been grown as a fodder crop, and under similar conditions to the last-named crop did not flourish, but still gave a return at the rate of 33,000 lb. per acre.

CHINESE SUGAR-CANE OR SORGHUM SACCHARATUM—was first introduced on the Farm from Sydney in the early part of 1870 and has now become established as one of the regular cold-weather crops.

It can be grown readily with as little trouble as the common cholum, but, unlike that crop, good results have not yet been generally obtained from hot-weather sowings. It has been tried frequently during the hot season but usually with the same want of success. The seed germinates well and produces plenty of plants, but they are generally sickly and stunted and rarely produce more than one-fourth of a cold-weather crop. This is very different from the ordinary cholum, which with water will grow well at any time of the year, and often better in the hot than in the cold season.

In 1879, however, partial success was attained with a hot-weather sowing made in the experimental grounds. For this experiment three beds were used, which were all similarly prepared and the soil of which was alike. The seed was sown on the 27th July; in the first bed half an inch, in the second 2 inches, and in the third 4 inches deep; it germinated well and the plants grew vigorously. The crop was watered occasionally and was cut on the 16th October. The yield was as follows :—

Bed.	Depth of sowing seed.	Yield.	Yield per acre.
		LB.	LB.
A 1 ...	½ inch	520	34,956
A 2 ...	2 inches	622	41,812
A 3 ...	4 do.	678	45,577

It must, however, be mentioned that the favorable result was undoubtedly greatly due to the peculiar weather, which was very favorable for growing crops, during August and September.

Land intended for this crop should be in good condition both physically and manurally. Seed may be sown at the rate of from 10 to 20 lb. per acre, either on the flat or on the ridge; the former method requiring more seed and giving lighter crops than the latter, but it is more expeditious and cheaper. It has been suggested that transplanting might suit the habits of the sorghum plant, but it is seldom in this country that this can be done without great expense and seriously delaying farm work. Transplanting may answer well enough for planting a few square yards with sorghum in a kitchen-garden, but is altogether unsuited for operations in the field, excepting, perhaps, under irrigation. The crop only occupies the ground about 100 days, and even less if it be only grown for fodder.

In the season of drought in 1876, a crop of 924 lb. grain and 5,103 lb. of straw was raised from Sydney seed sown at the rate of 8 lb. per acre; it occupied the ground 100 days from 17th October to 24th January 1877. The soil was a light sandy loam which had lain fallow the previous year and had been heavily manured with box-manure. The crop was also top-dressed with saltpetre, and probably, had rather more seed been used, would have been heavier, at least in the outturn of straw.

In the season of 1881, 37 lb. of Sydney seed, under ordinary treatment, produced in 128 days 2,399 lb. of grain and 36,023 lb. of straw, or 636 lb. of grain and 9,555 lb. of straw per acre. The crop is therefore a good grain as well as straw yielder; it is, however,

rather recommended as a fodder and not as a grain crop to the farmers of this country; it will yield two or three successive cuttings of fodder under good cultivation when occasionally watered, but it does not throw out so many fresh stems as the cholums of this country do after each cutting. The fodder is very valuable both for dairy and working cattle. The stems contain a large amount of saccharine matter, but it has been found difficult to get the syrup obtained from them to crystallize.

IMPHEE AND PLANTER'S FRIEND—have both been grown; they are supposed to have been originally obtained from the south-eastern coast of Africa. They are regarded as equal as sugar plants in America to the Chinese sugar-cane. A few pounds of seed of the former were obtained from Sydney and sown on the 30th of November 1870, but its growth was very unsatisfactory; it did not produce more than one-tenth of the crop Chinese sugar-cane yielded, whilst it required a much longer time in coming to maturity. The canes were thick, but very short, and the presence of any more saccharine matter than is found in our common cholums could not be detected.

Planter's friend was first tried in 1875, and the results were satisfactory; it has been found to yield from 4,000 to 12,000 lb. of straw, besides a crop of grain, per acre; it was, however, regarded especially as a fodder-producer. The straw of this variety is very rich in saccharine matter. The results which have been obtained show abundantly that both "sorghum" and "planter's friend" are most valuable fodder-producers. The former gives a heavier yield of grain than the latter, but it may be remarked here that the grain of both varieties is at present unsaleable at Saidápet for use as food for man; that of the sorghum because of the difficulty in removing the husk, that of the planter's friend because of a bitter taste which it possesses.

That the crop is a very hardy one the following quotation from the report for the year 1879-80 will show:—

"*Crop No. 13—Planter's friend (Sorghum Kaffrarium).*—The field (No. 27) in which this crop grew is one of the worst on the Farm; it was levelled about four years ago, at which time it was necessary to strip the land in some parts more than a yard deep in order to bring its surface to a regular slope. The bad effects of removing the surface soil have been shown by barrenness of the land stripped, the stiffer portions of it having produced little or no crop ever since. The soil varies from clay to sand; the portion stripped most deeply is stiff and has a very close texture, so that even after a light shower of rain the water accumulates on the land, and whenever heavy rain is followed by great evaporation salt rises and is deposited on the surface. The land was ploughed several times between June and August, and was as well prepared for sowing as the diversity of the soil admitted. Horse manure was applied at the rate of nine tons per acre, after which the planter's friend was sown on alternate ridges with cotton. The seed germinated freely and tolerably evenly over the ground. The dry weather of September was unfavorable for the growth of the plants, and they appeared stunted at the end of the month, but recovered tolerably well after the rains at the commencement of October. The yield, 499 lb. of grain per acre, is, considering that the land was unable to carry any other crop before, good. The crop grew on the stiff as well as it did on the sandy soil and in the salty portions of the field. It is the only crop that has grown at all well on the land."

Recently some investigations have been made as to the capacity of these crops as sugar producers. As they only occupy the land about 3 months and will produce from 5 to 10 tons of green stem ready for crushing, they may form a valuable addition to the sugar crops of this country. In 1880, at the same time as some experiments in crushing sugar-cane were in progress, an experiment was made with canes both of the Planter's friend and *Sorghum saccharatum*, regarding which the following results may be quoted:—

"Unfortunately no perfectly fresh stalks of planter's friend were available at the time, and it is probable that all the sugar of the sample experimented with was not extracted. The following are the results of an examination made by Mr. Hamilton, Chemical Lecturer in the School of Agriculture, of the juices expressed; the juice of some ordinary sugar-cane having also been tested at the same time.

Juice extracted from	Specific gravity.	Crystallizable sugar.	Uncrystallizable sugar.
		PER CENT.	PER CENT.
Sugar-cane	1065	15·07	8·42
Sorghum	1061	9·03	5·68
Planter's friend	1064	5·101	3·83

"These results, as far as they go, show that both the sorghum and planter's friend cultivated here are rich in sugar, but it will be necessary to devote attention to the best time for cutting, for crushing, and also the treatment of the juice afterwards. The large amount of uncrystallizable sugar in the juices may have been partly due to the time at which the crops were cut and also to their being stored.

"Regarding *Sorghum saccharatum* Mr. Hamilton afforded the following information: 'The stems of some sorghum plants, with the seeds ripening, were cut into segments and split, and 2 lb. of the stems so prepared were put into a clean screw-press. Eleven ounces of juice were expressed, beautifully clear and having a fine olive-green color.' This juice gave the following results:—

Specific gravity	1059
Crystallizable sugar	10·32 per cent.
Uncrystallizable sugar	1·79 do.

"These results, owing to the care in expressing the juice, the freshness of the sample, and the avoidance of delay in determining the sugar, are more reliable than those before given.

"In crushing, by means of the mill before referred to, 100 stalks of each crop, and making the juice into jaggery, the following results were obtained:—

Plant.	Weight of canes crushed.	Juice extracted.		Yield of jaggery.		
		Weight.	Per cent. of canes.	Total.	Per cent. of canes.	Per cent. of juice.
	LB.	LB.		LB.		
Planter's friend	24	10·75	44·8	1·25	5·2	11·6
Sorghum	29·5	10·50	35·6	1·375	4·7	13·1

"The stalks were stripped before being crushed, and, compared with the yield obtained in America, the percentage of juice is low, but it should be remembered that the canes were not in the best state for crushing. It is believed also that in stripping the canes there is a loss of juice. If further experience shows that the removal of the stem leaves when clean is unnecessary, as there is reason to believe, there will be a considerable saving in the cost of making jaggery, as stripping the canes is costly."

In the following year several further experiments were made in converting the juice of the planter's friend into jaggery, nothing further having been done with the Chinese sugar-cane as it was found so difficult to get the sugar of the syrup to crystallize. The following were the results:—

Date of experiment.	Weight of		Yield of juice.			Yield of jaggery.		
	Ripe canes stripped.	Heads of ripe canes.	Volume.	Weight.	Per 100 lb. canes.	Total.	Per 100 lb. juice.	Per 100 lb. canes.
	LB.	LB.	CUB. IN.	LB.	LB.	LB.	LB.	LB.
February 15th	817	116	9,000	360	44	37	10·3	4·5
Do. 16th	787	162	6,900	276	35	35	12·6	4·4
October 26th	280	45	2,300	112	40	10·75	9·6	3·8
Do. 27th	500	35	3,600	124	24·8	17	13·7	3·4
Do. 28 and 29th ...	593	37	3,900	161	27	22	13·6	3·7

Early Amber Sugar-cane.—This variety of sorghum originated in the State of Indiana in 1860 from a plant which appeared in a crop of Chinese sorghum grown from seed purchased in Paris. The seed of this plant was sown, and the produce again sown; which process having been repeated for several years, a large quantity of the seed has been produced. Through the agency of the United States Agricultural Department, the seed has been widely distributed over the various States, more specially in Minnesota, where it has thriven well. It obtained its name from its habit of ripening earlier than the ordinary sorghum, and in America is said to produce 120—150 gallons of syrup per acre and about 6 lb. of crystallized sugar per gallon, or 720—900 lb. of sugar per acre.

The first supply of seed was obtained from America in May 1879 and has since produced several crops on the Farm. A small plot sown in November 1879 and harvested in April 1880 yielded at the rate of 21,511 lb. straw and 370 lb. seed per acre; another large plot sown in August and harvested in December 1880 gave 14,160 lb. straw and 78 lb. seed per acre. At first it did not thrive on the Farm, giving only small returns; during the season of 1881-82, however, on 2·63 acres sown with 53½ lb. seed an outturn equal to 228 lb. grain and 12,038 lb. of straw per acre was obtained, and this must be regarded as a partial outturn, for the crops were cut experimentally in different stages of growth and partly before the seed appeared, whilst a large portion, 1¾ acre, was sown very late in the season and had to encounter a long drought.

Numerous experiments were made in crushing the canes of these crops and converting the juice into jaggery: the following are the results of one set made in October 1881:—

Date.	No. of canes crushed.	Weight of		Yield of juice.			Yield of jaggery.		
		Canes.	Heads.	Volume.	Weight.	Per 100 lb. of canes.	Total.	Per 100 lb. of juice.	Per 100 lb. of canes.
		LB.	LB.	CUB. IN.	LB.	LB.	LB.	LB.	LB.
19th ...	1,000 each time.	593	79	4,850	197	33·22	23·75	12·00	4·00
20th ...		525	47	4,400	164·25	31·28	27	16·43	5·14
21st ...		476	45	3,800	149	31·30	22·5	15·10	4·72
22nd ...		474	46	3,950	154	32·48	21·5	13·96	4·53
24th ...		457	38	3,250	141	30·85	17·25	12·23	3·77
25th ...		452	41	3,000	137	30·30	20	14·59	4·42
31st ...	1,300	500	40	3,500	139	27·80	21·5	15·46	4·30

Another set of experiments was instituted in February 1882, the results of which are recorded in the next table.

Date.	Weight of portions dealt with.						Yield of juice.			Yield of jaggery.		
	Canes with leaves total.	Ripe heads.	Unripe canes not crushed.	Leaves stripped.	Canes crushed.		Volume.	Weight.	Per 100 lb. of canes.	Weight.	Per 100 lb. of juice.	Per 100 lb. of canes.
					Stripped.	Unstripped.						
	LB.	LB.	LB.	LB.	LB.	LB.	CUB. IN.	LB.	LB.	LB.	LB.	LB.
3rd ...	1,464	...	...	...	...	1,464	5,250	194	13	25	12·8	1·7
4th ...	1,335	...	...	...	...	1,335	6,300	231	17	27	11·6	2·0
6th ...	1,260	56	756	66	382	...	4,800	182	48	24	13·1	6·3
7th ...	2,343	140	1,064	112	1,027	...	12,450	498	48	60	12·0	5·8
9th ...	1,168	117	686	...	365	...	4,450	177	48	30	16·9	8·2
10th ...	877	67	280	51	479	...	6,750	270	56	30	11·1	6·2
11th ...	905·5	63·5	368	46	428	...	5,700	228	53	30	13·1	7·0
14th ...	692	42	207	60	383	...	4,300	172	45	18·5	10·7	4·8
17th ...	1,035	56	504	53	422	...	5,300	212	50	24	11·3	5·6
22nd ...	1,113	54	509	56	494	...	5,300	212	43	28·75	13·5	5·8
23rd ...	1,702	74	756	80	792	...	9,850	394	50	38	9·6	4·8

Cream of lime was mixed with the juice before it was boiled until an alkaline reaction was observed. Crystallization began usually within twenty-four hours after the syrup cooled; in some cases much earlier. Experiments were made to ascertain the proper time for the removal of the syrup from the fire, and under what conditions the best colored jaggery could be obtained. It was noticed that the syrup was lighter in color when removed from the fire early, but crystallization was slower. When the juice was boiled for a longer time, it became darker, but crystallized rapidly.

It was found when these experiments were begun, that not more than 50 per cent. of the plants were sufficiently ripe, but, as it was

intended to continue them over two or three weeks, it was not thought advisable to wait for all the canes to ripen, for those unfitted for crushing could be usefully employed for feeding the milch cows. From the table it will be seen that on the first two days the outturn of jaggery was very poor, but on these days the whole of the plants was crushed. The yield of jaggery being so low, while its color was so dark, it was thought advisable thereafter to crush only the riper canes. It will be observed that when this was done the percentage of juice rose considerably, as well as the percentage of jaggery. It is evident from these experiments that it is in every way better to crush only the best canes, and to use those that are less ripe and the leaves for feeding stock. By selecting the seed, and by good tillage and good treatment, much greater uniformity in the ripening of the canes may be secured This is a point to which attention is specially required, for it is both troublesome and expensive to divide the crop into matured and unripe canes; and but little advantage would be gained by harvesting, first, the matured canes, and afterwards the others as they ripened.

The syrup of the amber sugar-cane crystallizes far more rapidly, and to a much more considerable extent, than the syrups of either the *Sorghum saccharatum* or *Sorghum Kaffrarium*. The refuse canes, after crushing, are far more palatable to stock than the refuse of sugar-cane; and, judging from its appearance and general character, the refuse sorghum must be far more digestible.

Some further experiments were made in January 1883 in extracting the juice of this plant and in converting it into jaggery. The following statement affords full information regarding these experiments :—

Date.	Crushing.		Weight of		Yield of juice.			Defecation of juice.							Evaporating.				Jaggery obtained.		
	Commenced.	Finished.	Tops and ears.	Stripped canes crushed.	Volume.	Weight.	Per 100 lb. of canes.	Commenced heating.	Cream of lime added. At	Cream of lime added. Amount.	Cream of lime added. Temperature of juice.	Removed from fire at	Temperature when completed.	Sulphuric acid used.	Commenced at	Scum removed. At	Scum removed. Amount.	Finished at.	Weight.	Per 100 lb. of juice.	Per 100 lb. of canes.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	A.M.	A.M.	LB.	LB.	CUB. IN.	LB.	LB.	A.M.	P.M.	CUB. IN.	DEG.	P.M.	DEG.	CRS.	P.M.	P.M.	LB.	P.M.	LB.	LB.	LB.
23rd ...	10-30	11-10	20	200	2,500	100	50	11-20	12-40	25	160	12-20	212	...	12-45	1-15	5	3-20	13	13·0	6·5
24th ...	1	11-45	21	225	2,633⅓	106	47·1	P.M. 12-50	2	37½	160	2-29	212	...	2-5	3-23	5⅛	5-20	14	13·2	6·2
25th ...	11-7	11-50	16	210	2,400	92	43·8	12-42	1-55	25	160	2-23	212	...	2	3-20	4¾	4-55	11	11·9	5·2
26th ...	11	11-40	16	230	2,400	94	40·8	A.M. 11-50	12-40	25	160	1-50	212	...	1-5	2-35	4½	4-20	11½	12·2	5·0
27th ...	11-45	P.M. 1	20	170	2,200	95	50	P.M. 1-15	2-18	37½	182	2-50	218	25	3	2-45	3	4-30	10½	12·3	6·1
29th ...	11-30	12-45	16	190	2,500	99	52·1	1	2-10	25	182	2-40	218	25	2-45	2-35	5	4-13	11½	11·6	6·0
30th ..	11	A.M. 11-50	14	201	2,250	90	44·7	12-50	2	25	182	2-35	218	25	2-40	2-30	3	4-10	10½	11·6	5·2
31st ...	10-45	11-26	18	200	2,400	96	48	12-30	1-45	25	182	2-30	218	25	2-25	2-15	5½	4-17	12	12·5	6·0

The average outturn of jaggery was fairly satisfactory, as with a cane crop of 20,000 lb. per acre, the yield would be 1,200 lb., and besides the jaggery there would be the refuse cane and probably 500 or 600 lb. of grain. The refuse cane and grain are well suited for feeding stock.

SUGAR-CANE.—A small plot, measuring about 2,000 square yards, was planted with sugar-cane in 1872. The experiment was instituted merely to ascertain whether sugar-cane could be grown profitably on the ordinary soils of the Farm. The crop was manured with slaughter-house refuse only. The following are the results. The crop was planted during the first week in February and was harvested at about the same time in the following year; it was planted in lines about 3½ feet apart; there were 35 lines; of these, 24 were sold to bazaarmen for Rs. 69-8-9 and the remaining 11 lines, which were the best, and valued at Rs. 4 per line, were kept for Farm use to provide cuttings for planting another crop. The total return was thus, say, Rs. 113-8-9, or Rs. 274-12-6 per acre, against an expenditure amounting to Rs. 106-8-0, or Rs. 257-11-8 per acre, a large portion of which was taken up in raising water 20 feet high. However, in the case of a ryot who, instead of hiring all the necessary labor, works his land himself with the aid of an occasional laborer, the actual expenditure would have been very small, and the return obtained from the crop would have been ample to compensate him.

In order to test the capabilities of the crop as a fodder-producer, an average row of canes was cut down in November; the canes weighed 1,162 lb. and the toppings 392 lb., or together 1,554 lb., equal to 131,624 lb. per acre, worth at least Rs. 290, so that it would have been far more profitable to have treated the crop as a fodder one, whilst, if the whole had been cut for fodder at the time the single row of canes was harvested, there would also have been a large saving in the cost of watering and weeding, and a large second crop would have been obtained. There can be no doubt but that sugar-cane as a fodder-producer is almost unequalled by any crop. Our Municipalities, with their abundant supplies of manure, might find it worth while to grow sugar-cane as a fodder crop; they might produce it in favorable localities at Rs. 5 per ton, at which price it should meet with a large demand for feeding milch cows and draught cattle.

A small plot of ·87 acre was planted out with this crop on 21st December 1879. The land had previously carried plantains, and during their growth had been brought into a fair condition. The soil, however, like the soils of the Farm generally, is naturally poor. The land can be watered from a well close by, which contains a good supply of water about 20 feet below the surface. The plantains were removed in June 1879, and the land ploughed and harrowed frequently during the ensuing months. On 9th December 18 cwts. of crushed bones were applied broadcast to the plot, and were ploughed in just before trenching for planting. One-half of the plot was trenched 3 feet apart and the other 6 feet, and the canes were planted in the bottom of the trenches after watering. After planting, the land was occasionally watered to sprout the canes, and ashes were applied to check the ravages of the white-ants. The canes sprouted fairly, although a good many blanks were caused by the white-ants; and the crop continued

healthy and to make good progress until the middle of March, when 3 tons of poudrette was applied. The progress of the crop, except on a portion of the part planted in rows 6 feet apart, which never did well, continued to be good. At the end of April, 23 loads of slaughter-house refuse were applied. A few rows (four) of the closely planted crop received a further application of manure at the end of May, and the crop continued to progress fairly until the middle of June, when it received a check, but soon recovered and continued healthy throughout the remainder of its growth. In August 1,270 canes were taken out for use as seed-cane in another field of the Farm, and again in November 304 canes were removed for the same purpose. By the end of December the canes were fit to cut. Some of them were sold standing; a row 80 yards long being sold for Rs. 2-4-0, or at the rate of Rs. 136-2-0 per acre. During January and the early part of February the whole crop was removed and the greater part crushed in one of Thomson and Mylne's Beheea sugar-mills, and the juice boiled down into jaggery. Canes weighing 12,383 lb. were crushed, and yielded 780¼ lb. of jaggery, which sold for Rs. 46-9-0. The yield of jaggery from an average row of canes was about 34 lb., worth Rs. 2-0-4. The total outturn of canes was not recorded, but in the following table some results obtained from part of the different plots are given.

Plot planted.	Number of rows.	Area.	Weight of canes		Jaggery made.		
			Crushed.	Per acre.	Total.	Per acre.	Per 100 lb. of canes.
		SQ. YDS.	LB.	LB.	LB.	LB.	LB.
3 feet apart ...	16	1,280	7,642	28,896	485¾	1,836·7	6·36
6 do. ...	8	1,280	4,741	8,555	294½	1,113·5	6·2

These results show that it is more profitable here to sell the canes standing for retail sale in the bazaar, and that, on soil of the nature of that in the field where this crop was raised, the crop does better in every way if planted in rows only 3 feet and not 6 feet apart.

At the time of crushing the above cane, an experiment was made compare its sugar-producing quality with that of cane raised in the neighbourhood, for which purpose some canes were purchased. The results were as follow :—

Canes.	Weight crushed.	Yield of juice.		Yield of jaggery.			Remarks.
		Weight.	Per cent. of canes.	Weight.	Per cent. of juice.	Per cent. of canes.	
	LB.	LB.		LB.			
Purchased	59	31	52·5	3	9·7	5·1	The Farm canes only averaged 4 feet in length, whilst those purchased averaged 5½ feet in length.
Farm-grown ...	40·75	26·25	64·4	3·5	13·3	8·6	

There is nothing to show how the purchased canes had been treated during their growth, but the results are satisfactory, especially when the poverty of the Farm soil is considered. The proportion of jaggery obtained in this case was higher than the general average with Farm-grown canes, but this may have been due to several causes —more efficient extraction, less concentration, &c.

In the following table the results in sugar-making with the different varieties of sorghum and sugar-cane referred to above are summarized :—

Yield from.	Maize, December 1881.	Planter's friend, 1880.	Sugar sorghum, 1880.	Planter's friend, 1881.	Amber sugar-cane, October 1881.	Amber sugar-cane, February 1882.	Amber sugar-cane, January 1883.	Sugar-cane, 1880.
100 lb. of canes—	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
Juice	25·07	44·8	35·6	34·1	31·03	42·8	47·06	64·4
Jaggery	3	5·2	4·7	3·9	4·41	5·2	5·7	7·03
100 lb. of juice—								
Jaggery	11·9	11·6	13·1	11·9	14·25	12·3	12·3	13·3

Cumbu, Spiked or Pearl Millet—is an indigenous plant especially suited for cultivation during a season of high temperature and light rainfall on lands which it is not possible to irrigate. It is chiefly grown on the poorer classes of soils and does not produce very heavily. It grows well in some localities under irrigation, but does not come up to cholum either in productive powers or in the quality of the forage produced. Notwithstanding this, it is a valuable crop for growth in the hot weather before the regular cold season crops can be sown. The value of the fodder is referred to in another place; the grain meets with easy sale, but is of low value. The crop produces fodder at a time when there is generally great scarcity of cattle food in this neighbourhood. It is possible always to have something green for the stock between the months of October and May; but the great difficulty is to find some crop that will yield green fodder during the months of June, July, and August. Of course under irrigation it is possible to grow yellow cholum, so as to afford a supply of green fodder throughout the hot season, but there are large tracts of country to which irrigation cannot be applied in which cumbu will yield excellent green fodder during the season when the stock feeder finds it the most difficult to maintain the condition of his animals.

Raggy—is a fair fodder-producer, and yields a valuable food-grain under moderate irrigation at all seasons of the year and during the cold weather without. It is easily grown and is extensively raised under wells during the hot season, being planted out from seed-beds. The best plan is to ridge up the land, as is done for maize and cotton, and to plant the seedlings on both sides of the ridges. The crop is a difficult and expensive one to harvest owing to the ears never ripening at one time, and it is also costly to thresh, the grain adhering with great persistency to the panicle.

The following extract from the report for 1883-84 gives some interesting information regarding the production of this crop :—

"The total area sown with raggy on the Farm, including the botanical garden, was 6·36 acres, and the total outturn was 4,757 lb. grain and 14,858 lb. straw, or 748 lb. grain and 2,336 lb. straw per acre. In field No. 11 alone, where the soil is comparatively good, the yield was 1,084 lb. grain and 4,976 lb. straw per acre; while in field No. 23, which is very poor and sandy, the outturn was about 296 lb. grain and 1,391 lb. straw; and the average outturn from field No. 8 and the C plots of the botanical garden was 718 lb. grain and 1,172 lb. straw. The proportion of grain to straw differed very much in these cases. In No. 11 it was about 1 : 3; in No. 23, 1 : 6; whilst in the botanical garden it was not properly determinable. There was a considerable loss by shedding from the crop in No. 11 field, as it was not reaped early enough, for, according to previous experience, it was believed that raggy does not shed its grain to any appreciable extent, and so particular care was not taken to reap the crop as early as possible. In previous years, the average outturn of unirrigated raggy has been 524 lb. grain and 2,171 lb. straw, and, excepting the crop obtained from field No. 14 in 1880-81, no more than 693 lb. raggy per acre has been obtained in previous years. The outturn of 941 lb. of grain and 4,197 lb. straw obtained in 1869-70 from an irrigated raggy crop was the highest ever obtained on the Farm in previous years. The outturn from No. 11 of 1,084 lb. grain and 4,976 lb. straw is therefore most satisfactory, especially in a season which proved so disastrous to the other unirrigated crops. The following table shows the outturn of raggy crops obtained in recent years:

Year.	Number of field.	Area of the plot.	Outturn.			
			Grain.	Straw.	Grain per acre.	Straw per acre.
		ACRES.	LB.	LB.	LB.	LB.
1879-80 ...	18	2·29	1,589	1,557	693	680
1880-81 ...	1	·595	408	1,197	686	2,012
1880-81 ...	14	2·31	1,729	2,352	748	1,018
1880-81 ...	33	2·36	841	2,351	356	996
1881-82 ...	23-B.	4·2	2,099	9,437	499	2,247
1881-82 ...	28-II	·40	170	516	425	1,290
1881-82 ...	28-III	·99	480	1,009	485	1,019
1881-82 ...	34-I	1·38	422	6,522	305	4,726
			Irrigated Raggy.			
1869-70 ...	Not known.	sq. yds. 3,420	665	2,324	941	4,197
1877-78 ...	35-VII	1·20	773	9,390	640	7,779
1877-78 ...	36-III	·94	514	3,568	547	3,796
1878-79 ...	35-I	·35	116	1,680	331	4,800
1879-80 ...	30	1·00	347	2,333	347	2,333

The following experiment was made to ascertain what percentage of moisture is eventually lost by evaporation if grain is threshed immediately after harvest with the following results; fresh raggy being taken:—

Date of weighing.	Weight of grain.	Loss.
	LB.	LB.
29th January	772	...
4th February	690	82
13th do.	686	4
20th do.	686	*Nil.*

The total loss was 86 lb. or about 11·14 per cent. of the weight of fresh seed. Similar deductions should be made on crop estimates based on field weighings.

ITALIAN MILLET—has been crop on more than one occasion on the Farm with tolerable success; it produces a fair crop of grain as well as straw. The grain is difficult to thresh, and does not command a ready sale. It needs no special cultivation.

LITTLE MILLET OR SHAMAY—is an inferior crop of no great value as a grain-producer; it grows readily on poor soils, and is a valuable fodder-producer under irrigation. The following experiment was made with it as a fodder crop: a plot measuring 744 square yards was sown with 10 lb. of seed on the 2nd of August. The crop grew rapidly and with great luxuriance. On the 25th of October, when most of the plants were coming into ear, the whole was cut down, and yielded 4,575 lb. of excellent fodder; this was dried and made into hay, which, when cured, weighed 1,411 lb. After the removal of the first cutting the plants again started vigorously, and on the 18th of December another cutting, weighing 2,673 lb., was obtained; this, when dried, yielded 925 lb. of hay. The total return thus obtained from the plot during the four months that elapsed between the sowing of the crop and the harvesting of the second cutting was 7,248 lb. of fodder, which gave 2,336 lb. of hay, equal to 47,151 lb. of fodder, or 15,197 lb. of hay per acre. The land had been manured with four loads of box-manure, and the crop was watered seven times, but during the time it was on the ground the rainfall generally was copious, hence it was seldom necessary to irrigate. Had it been necessary to water the crop regularly throughout the whole time it was growing, the cost of producing the fodder would have been largely increased: it was under Rs. 2 per ton.

COMMON MILLET OR VARAGU—is a crop not worth much attention; the grain is very inferior and commands a very small price in the bazaars, while it is a very slow grower, occupying the land a long time. In one case about 2 acres were put under this crop; the soil was prepared in the usual way and manured with 5 tons of fold-yard manure per acre; about 24 lb. of seed was sown in drills 22 inches apart in the early part of October. The crop was harvested on the 1st of March, and yielded 456 lb. of grain; the straw would not weigh more than half a ton per acre.

PADDY.—Both of the car and sumba local varieties have been extensively grown from time to time. It is popularly believed that the amount of water generally used for irrigating the crop is far in excess of its actual requirements, which is the more to be deplored for the crop is of a low type, and produces a poor food; it developes habits of idleness and unthrift in the people from the ease with which it may be grown, and consequently leads to the adoption of negligent methods of cultivation; it is insanitary in its effects, causing, under the system of the native cultivator, the presence of large bodies of generally stagnant water—a fertile source of malarious fever; and finally it monopolises water which might be far more usefully employed for irrigating maize, wheat, or other crops which might be grown with a tithe of the water now used for paddy, whilst the food they would produce

would be equal or greater in quantity, and of far better quality. What the effects would be of an outbreak of a disease on this crop, which might, as the potato disease did in Ireland, destroy the greatest food resource of the people, it is difficult to contemplate; and yet the extension of irrigation works on the old system goes on, and consequently that of paddy culture.

As a fodder crop, paddy is a good producer. Numerous experiments with this object have been made on crops grown in the usual way; some from seed and others from transplanted seedlings. As a general rule, the best results were obtained from seed which had been sown broadcast. The fodder was always harvested when the plants were in the shot-blade, just before the flower appeared; the outturn was found to be about 18,000 to 20,000 lb. per acre, which could be produced at the rate of 929 lb. per rupee, or at about Rs. 2-6-7 per ton. It is in the power of every ryot who owns ordinary paddy land, with a moderate supply of water, to produce similar results, while those who can apply irrigation water by gravitation can produce the fodder at a much lower cost.

Of course, the distance from a market will limit the remunerative cultivation of paddy fodder to but a small portion of the land now under paddy, still there is no doubt but that near our larger towns, within a distance of six or eight miles, a large proportion of the land might profitably be employed in growing fodder, not continuously, but in alternation with a crop of grain; and certainly during seasons of long drought, when cattle are starving and the ryot and his people idle, the water available, though it would not nearly suffice to bring a crop of grain to maturity, might be turned to account in growing a crop of paddy fodder. It is lamentable at such times, when large tracts of country are lying idle and cattle dying off, to see here and there a few feet of water in the tanks left unused because there is not enough to mature a crop, though it might suffice for raising a crop of paddy fodder. However, if a bad season comes, the ryot seems quite without resource; he folds his arms and blames his unfortunate fate.

Owners of horses could effect a very considerable saving in the cost of their stables by substituting paddy fodder for a portion of the grass now supplied by grass-cutters. At the rate of wages usually paid to these people, this grass seldom costs less than 12 rupees a ton. Paddy hay is better given chaffed than uncut as a horse fodder. The hay may be valued at 9 rupees a ton, and the cost of chaffing it would be about one rupee a ton.

Burmese Paddy.—A few pounds of some of the best kinds of Burmese paddy were obtained in 1873 from Rangoon. Each variety was sown on a separate plot of land, the cultivation adopted being precisely that under which indigenous paddy is raised. The general results were not good, a large number of the plants producing small inferior grain, but this may to some extent have been the result of the great change in climate, especially as the crops matured in the early part of the dry season, at which time the dryness of the air in Madras affords a very marked contrast to the state of the atmosphere most

common in Burmah. These varieties are much more highly esteemed by natives than the paddy generally grown in Southern India.

Carolina Paddy.—Many experiments have been made with this variety, both with seed imported direct, and with seed raised in this country; the results have been highly satisfactory, and have proved that the native system can be adapted to its growth, if only less water be used, deeper cultivation be adopted, and more attention be paid to drainage. Good results can be obtained either by sowing the seed at once in the paddy bed, or by sowing it in a seed bed and afterwards transplanting the plants to the paddy bed: either procedure may be justified by the peculiar circumstances of the ryot. It has been found that remunerative crops of country paddy can be produced on a soil that altogether fails in producing a fair crop of Carolina paddy, and also that a soil which one year produces a good crop of this grain may, in the next, not be able to produce even half a crop. Thus, soils which in 1870 produced as much as 2,000 lb. per acre of Carolina paddy yielded in 1871 only half as much, though equally well cultivated and manured: the explanation of this is simple; the soils which produced such good crops of Carolina paddy in 1870 were in a fresh state at the time the paddy was sown; they had not been under wet cultivation for several years, while those sown in the following year with this paddy had been under wet cultivation in the previous year, and had become more or less reduced by the stagnation of the irrigating water in the sub-soil to the condition of the more inferior descriptions of paddy land; or, in other words, to a sour, unhealthy, soapy condition, in which atmospheric agencies are able to have no effect for good, in which plant food is either locked up and rendered inert, or formed into combinations more or less injurious to vegetable life, but whose surface to a depth of 2 or 3 inches is more or less healthy and capable of producing plants of a low type. It is easy to understand why, on a soil in this condition, Carolina paddy seldom does well, while country paddy may thrive. The former feeds deep down in the soil; it has long deep roots, varying in length, under average circumstances from 4 to 6 inches, while few of the rootlets are horizontal. It is very different with the roots of country paddy; nearly the whole of its rootlets radiate over the surface of the ground at right angles to the stem of the plant. They are seldom more than 2 or 3 inches in length, and are so interwoven as to form a sort of network well suited for supporting the plant on the semi-liquid mud in which this variety delights to grow. Hence a soil in a bad physical state, if it only has a healthy surface 2 or 3 inches in depth, may produce fair crops of country paddy, though it will entirely fail in producing a crop of Carolina paddy. On such a soil the Carolina paddy would start as well as the country paddy, and would continue to grow as well, until its roots began to penetrate below the aerated soil, when its growth would be checked, and it would gradually turn yellow and sicken.

It was expected by many that the sample imported would deteriorate; this does not necessarily follow, for, although deterioration must take place if the crop be grown under very unfavorable circumstances, if properly cultivated it will not. In preparing rice from ordinary

Carolina paddy, by means of the pestle and mortar, in the usual manner adopted by natives, the following results were obtained :—

Clean rice	67·24	per cent.
Small rice	8·48	do.
Tour	5·24	do.
Husks, &c.	19·04	do.
	100·00	

Regarding the cultivation of the crop the following advice is given :—

" *Soil, &c.*—Carolina paddy has a very strong aversion to stagnant water ; therefore avoid all land on which, from imperfect drainage, water is likely to collect and stagnate. Remember that water may stagnate in the soil as well as on its surface. Select good healthy paddy-land resting on a moderately porous sub-soil and with a surface sufficiently high that it will not become a swamp during the rains, while it is yet sufficiently low to admit of being watered at a moderate cost. In the endeavour to avoid a soil that is too retentive, take care that you do not select one that parts too readily with its moisture, as a soil with this defect is as objectionable as one that is too retentive. Endeavour to select a soil that is neither too retentive nor too porous; in every taluk there are hundreds of acres of wet land that fulfil these conditions. These observations refer chiefly to the physical or mechanical condition of the soil. It is of much greater importance to secure a soil in a good physical condition than one in a high manural condition, as by the application of a suitable quality and quantity of manure the last-mentioned condition can be readily secured. Land which is being put under irrigation for the first time will nearly always produce good crops of Carolina paddy.

" *Preparation of the soil.*—The soil may be ploughed and worked in the dry state for sowing, or it may be ploughed under water and puddled. The former arrangement is much to be preferred; the latter is sometimes attended with advantages, but the evils which result from the wretched state in which the soil is left by the process are frequently of a very serious kind. But, whatever plan you adopt, take care to give the soil a liberal application of good manure during the time it is being prepared for the reception of seed.

" *Seed and Sowing.*—Choose fresh seed; it should be of a rich golden color; the sample should be uniform both as regards color and the size of the grain; if the seed is mixed with the seed of country paddy (which is the case almost invariably with all country-grown samples), and you cannot get a pure sample, you may, by using a fan and a bamboo sieve, remove the greater portion of the indigenous grain.

" Having selected suitable seed, and having prepared your land for its reception, you may proceed with the sowing. You may sow the seed at once on the land, or you may sow it in seed-beds and afterwards transplant the seedlings into the field. If you adopt the former of these arrangements, you may sow, say, at the rate of fifteen measures (30—35 lb.) per acre on either dry or puddled soil; if on dry soil, you may take the seed in its natural state and broadcast it or drill it in; but, if you prefer to sow on a puddled surface, you should sprout the seed before you sow it, and when this is done sow broadcast. When transplanting is preferred, take care that the nursery-bed is *deeply* dug and thoroughly manured. When this is done, the roots of the seedlings are small and compact, and the plants can be lifted with ease and without suffering any injury in the operation. To produce seedlings for transplanting, sow eight measures, or about 18 lb. of seed in the nursery-beds, for each acre of land to be planted; less will probably

suffice, but this quantity will provide against any loss. The seedlings may be lifted for transplanting when three or four weeks old: they should be planted in the field in the puddled or wet soil at distances of from 6 to 9 inches apart, a couple of seedlings being planted together. It may be good practice either to sow the seed at once in the field, or to sow it first in the nursery and afterwards to plant out the seedlings in the field. Thus, when the area to be sown is large, the season late, labor scarce, and seed plentiful and cheap, adopt the former plan, and the latter when the seed is scarce and dear, the area to be cropped small, the weather favorable, and labor plentiful.

"*Irrigating.**—In whatever way the land is sown or planted, it should be moderately watered the same day; this enables the seed to meet with a good bed and fixes the roots of the seedlings. It is seldom necessary to flood the land except to kill weeds or insects, especially after the plants begin to shade the soil. The endeavour should be to keep the land constantly damp, and not alternately in a state of puddle, and dry and filled with large cracks, as is too commonly the case with wet land under ordinary paddy culture.

"*After cultivations.*†—These are of a very simple nature; it is only necessary to keep the crop free of weeds and to thin out a few of the plants if the crop grows too luxuriantly."

Madagascar Paddy.—When searching through American works for information regarding the early history of Carolina paddy, it was found to be reported to have been descended from a variety imported into America from Madagascar. Samples of paddy were obtained from Madagascar, and one of them, known in Madagascar as Rajofotsky, appeared to merit attention. On comparing it with Carolina paddy the grain was found to be considerably larger, 846 grains of the former weighing one ounce to 990 grains of the latter. The rice from the latter was smaller, but whiter, plumper and more starchy than from the former. Cultivation of this variety on the Farm shows, however, that it is not the same as the common Carolina; it, however, possesses similar characteristics, showing a preference for a moderate supply of water, growing a strong robust straw, yielding heavily, and producing a large grain. It is especially remarkable for its broad leaves, which give the plants a bushy appearance, and tillers to a great extent, but it takes a long time to reach maturity (about 5-6 months).

Regarding a sample of the grain and two samples of rice, one prepared in the raw state and the other after moderate boiling, the following remarks were made :—

"The product of the experimental cultivation of this variety of rice appears to the Board to be of superior quality, and if Mr. Robertson's present opinion, that it thrives with a quantity of water less than the indigenous varieties, should be confirmed by further experience, the result should be of great value to localities where the rainfall is scanty and water not always abundant."

The samples were accordingly sent to the Most Honorable the Secretary of State for India in view to their professional valuation. The following are the reports on the samples :—

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* The practice suggested here is based on experience obtained in the neighbourhood of Madras, where the evaporation is great. In districts where the evaporation is less, and where the soil is moderately retentive, the American irrigation practice might be substituted.

† Hoeing is very beneficial and should be performed.

"Report on three samples of Madagascar rice from Madras, received for valuation from the India Office, dated London, 27th August 1881.

"A.—Madagascar paddy: bright and clean, but wanting in plumpness. Value about 6*s*. per cwt. (the freight would be a heavy item in importing rice in this form, as paddy is usually charged at 15 cwt. to the ton for freight).

"B.—Very imperfectly cleaned rice: value for starch-making 8*s*. 6*d*. per cwt.; it would have to be recleaned for eating purposes.

"C.—Fairly cleaned rice from paddy unhusked in boiling water: value 8*s*. 6*d*. per cwt. (there is an unusual demand for this sort of rice just now).

"(Signed) THOS. GRAY AND WALKER."

"*Note*.—All the samples much weevilled."

"Report on three samples of Madagascar paddy and rice from Madras, received from the India Office, dated 30th August 1881.

"A. Madagascar paddy.—This is difficult to value as the amount of husk is unknown, but we should think it would be about 25 per cent.; in that case the value would be about 6*s*. to 6*s*. 6*d*.; until a portion had been cleaned, it would be impossible to give a nearer quotation.

"B. Madagascar rice, raw.—Badly weevilled; value 7*s*. to 7*s*. 3*d*. per cwt.,

"C. Madagascar rice, boiled.—Considerably weevilled; value 7*s*. 9*d*. to 8*s*. per cwt.

"The samples B and C being *weevilled*, would, in the process of cleaning, break very considerably, and for that reason we are afraid to quote a higher valuation. The present prices of all rice on the spot are low, and distant shipments of soft grain rice (Rangoon, Bassein, &c.) are about 9*d*. per cwt. dearer than spot values, chiefly owing to the unfavorable harvest prospects. We think, therefore, that during the next two or three months we may reasonably expect better prices.

"(Signed) DEVITT AND HETT."

On receipt of these valuations, the Chairman of the Chamber of Commerce, Madras, was asked for information showing the prices of ordinary Madras paddy and rice in the London market at the time the foregoing valuations were made. He was good enough to reply as follows :—

"At the end of August, when the samples of Madagascar rice from Madras were reported upon by Messrs. Thos. Gray and Walker and Devitt and Hett in London, a good deal of Madras rice was sold in London as low as 7*s*. per cwt."

In 1882 a piece of land was set apart for a comparative irrigation experiment with Madagascar paddy and ordinary paddy; the former was obtained from a land-owner who had grown it from Farm seed; but it was so mixed with indigenous paddy that the results of the experiment can in no way be considered conclusive. A pure sample of the seed could not be got at the time. Half the land was divided into three plots, each containing 120 square yards, and planted with seedlings raised from the seed of the so-called Madagascar paddy. The other half was also divided into three plots, each of the same area, and planted on the same day with seedlings raised from goondoo

sumba seed. The plots in both sets of experiments were similarly tilled and manured, being ploughed twice and levelled, and ground-nut cake at the rate of 1,613 lb. per acre applied as manure. The seed had been sown in the nurseries on 1st October and the plants were put out on 16th November at the rate of 18 bundles of 8 inches girth to each plot. Water was applied six times during the growth of the crop, the water used being first collected in a cistern before use, and in this way the actual quantity used easily determined. The enormous rainfall of November was far beyond the requirements of the land; there were no means of determining what quantity flowed off the land, but it could not have been less than two-thirds of the total fall. This, of course, lessens the value of the experiment.

The crops flowered on 6th January 1883 and were harvested on 19th March with the results shown below :—

Number of plots.	Description of paddy.	Irrigation.					Details of harvest.				
		Water applied.			Actual rainfall.	Total quantity of water-supply.	Duration of growth.	Outturn.			
		Each time.	Total.	Equal to rainfall.				Per plot.		Per acre.	
								Grain	Straw.	Grain.	Straw.
		C.FT.	C.FT.	INCH.	INCH.	INCH.	DAYS.	LB.	LB.	LB.	LB.
1	Goondoo sumba.	90	540	6·0	34·89	40·89	165	56	279	2,258	11,253
2	Do. ...	180	1,080	12·0	34·89	46·89	165	53	199	2,137	8,026
3	Do. ...	270	1,620	18·0	34·89	52·89	165	43½	242½	1,754	9,780
1	Madagascar (mixed) ...	90	540	6·0	34·84	40·84	159	33	159	1,331	6,413
2	Do. ...	180	1,080	12·0	34·84	46·84	159	46½	205½	1,875	8,288
3	Do. ...	270	1,620	18·0	34·84	52·84	159	42	164	1,694	6,614

The outturn of the goondoo sumba plots was very good, and it is worthy of note that the lightest watering produced the best outturn; but, as has been noticed, no great importance must be attributed to this, the heavy rainfall having so complicated the experiment. The outturn on the three plots of the so-called Madagascar paddy was good; it is difficult to understand why plot No. 1 yielded so much less than the others. These experiments throw but little light on the question of the moderate or lavish use of irrigation water; such experiments require to be made under arrangements of a very complete nature, so much depending upon the physical state of the soil, peculiarities of the weather, &c.

In the following year a similar set of experiments was conducted with indigenous varieties of paddy on plots each measuring 1,080 square feet. The seedlings were 55 days old when planted on 2nd November. Rain fell on each day from the 1st to 9th (8·32 inches) and 18th to 20th (5·40 inches) of November, from the 11th to 16th December (10·86 inches), ·97 inch on 25th December, ·73 inch on 5th and 6th January, and 1·63 inch on 20th January; so that, during the growth of the crops, 26·76 inches of rain fell on 21 days. The crops were watered on the

following dates at the rates shown in the table below—13th and 29th November; 8th, 13th and 29th December; 3rd, 10th, 15th, 26th, and 31st January; and 5th, 16th and (plots 1, 2 and 3 only) on the 26th February. Plots 4, 5 and 6 were harvested on 23rd February and the others on 18th March. The results are given in the following table, it being remembered that a large proportion of the rain that fell ran or was drained off.

Number of plot.	Variety of paddy.	Number of times watered.	Quantity of water applied each time.	Total quantity equal to rainfall.	Total supply of water including rainfall.	Outturn			
						Total.		Per acre.	
						Grain.	Straw.	Grain.	Straw.
			C. FT.	INCH.	INCH.	LB.	LB.	LB.	LB.
1	Goondoo sumba ...	13	90	13	39·76	38½	536½	1,553	21,638
2	Do. ...	13	180	26	52·76	41	491	1,654	16,470
3	Do. ...	13	270	39	65·76	33	548	1,331	22,103
4	Sumba paddy ...	12	90	12	38·76	28	329	1,129	13,270
5	Do. ...	12	180	24	50·76	20	302	807	12,181
6	Do. ...	12	270	36	62·76	19½	224½	786½	9,055

The results of the experiments must have to a certain extent been vitiated by the heavy rainfall during the early growth of the crops, but the following figures show them clearly:—

Plots.	Watered each time with	Yielded per acre.			
		Grain.		Straw.	
		Average.	Ratio.	Average.	Ratio.
		LB.		LB.	
1 & 4	1 inch of water	1,341	100	17,454	100
2 & 5	2 inches of do.	1,230	91·7	14,325	82
3 & 6	3 do. of do.	1,059	78·9	15,579	89

These figures show very fair crops for the soil on which they were grown, and also, as far as they go, that the smaller quantity of water produced the best outturn, thus pointing in the same direction as all figures hitherto obtained have done, namely, that a much smaller quantity of water than is commonly used by the ryots will suffice to produce very good crops.

Fodder Crops and Grasses.—Among the many valuable results which have been obtained, proof of the fact that this country is pre-eminently favored with regard to forage crops is conspicuous; and the more so because these crops can be grown with the greatest ease with ordinary care and skill, and their valuable attributes were formerly almost unknown and unsuspected. Of their value the following figures,

giving the outturn of some field crops which have been grown on the Farm, are conclusive:—

Crop.	Growth and harvest.	Duration of growth.	Outturn per acre.
			LB.
Yellow cholum	Irrigated, 5 cuttings	11 months	51,870
Do.	Do. 4 do.	7 do.	48,168
Do.	Do. 1 do.	88 days	24,924
Do.	Do. 1st do.	81 do.	15,349
Do.	Do. 2nd do.	61 do.	19,648
Do.	Do. 1 do. in a paddy-field	177 do.	11,124
Do.	Unirrigated	5 months	17,024
Do.	Do.	73 days	13,305
Do.	Do.	132 do.	19,193
White cholum	Do.	112 do.	13,199
Do.	Irrigated, 2 cuttings	162 do.	13,128
Sorghum saccharatum	Do.	89 do.	16,444
Do.	Do.	107 do.	24,108
Do.	Irrigated hot-weather crop	89 do.	8,812
Amber sugar-cane	Unirrigated grain crop	97 do.	2,0942
Do.	Do. do.	80 do.	16,030
Planter's friend	Do. do.	106 do.	11,878
Do.	Do. do.	140 do.	14,000
Maize	Irrigated	90 do.	12,226
Do.	Do. grain crop	91 do.	17,280
Cumboo	Unirrigated	75 do.	15,000
Do. and Horsegram.	Do.	75 do.	8,346
Do. do.	Do.	63 do.	9,330
Do. do.	Do.	75 do.	8,346
Planter's friend and Horsegram	Do. in a paddy-field	117 do.	6,969
Horsegram	Do. do.	71 do.	10,642
Do.	Do. do.	117 do.	7,318
Do.	Do. do.	69 do.	8,100
Do.	Do. partially dry	143 do.	11,953
Do.	Do. in a paddy-field	143 do.	7,362
Do.	Do. do.	63 do.	7,260
Dew-gram	Do. do.	101 do.	16,753
Sugar-cane	Irrigated	9 months	131,624
Shamai	Do. 2 cuttings	138 days	47,151
Hariali grass	Do. 5 do. (dry)	1 year	19,376
Guinea-grass	Unirrigated, 2 cuttings	141 days	5,228
Do.	Do. 1 do.	...	8,555
Do.	Do. 1 do.	...	9,923
Do.	Do. 1 do.	...	9,680
Do.	Do. 1 do.	130 days	5,023
Car paddy	Irrigated	133 do.	18,075
Do.	Do.	67 do.	10,718

These results, obtained under such conditions as exist on the Farm, show most conclusively that with good farming it is possible to raise abundance of fodder, and that too, it can be proved, of first-rate quality, without any difficulty. There is therefore no reason, from want of proper and adequate food, why the country should not produce good stock instead of the miserably degenerate animals on which it at present chiefly depends for the cultivation of the land and for transport on the roads.

Many of the crops mentioned in the table have already been referred to; others will be mentioned below.

The growth of grasses specially for fodder, either by improving or cultivating natural pasture, is unknown in this country. Natural pasturage is decreasing under the encroachments of the plough, and such grazing grounds as exist are very unevenly distributed. The native grasses are, as far as is known, poor and coarse; a sward of grass is seldom if ever seen; tussocky growth being general. Very little has as yet been done in this important, and, to botanists, comparatively uninteresting branch of agricultural botany. The following are a few notes on such grasses as have been tried on the Farm.

Hariali (*Cynodon dactylon*)—the doob grass of Northern India, the couch grass of Australia and America—is a valuable but over-rated fodder plant, possessing great vitality and wide-spreading roots which are capable of propagating the grass from each section of them; it is suited to our long droughts and is also capable, under high cultivation and irrigation, of producing heavy cuttings of tough wiry fodder, which however possesses considerable nutritive qualities; on poor soils it is liable to be crushed out by inferior types of plants, but on those of fair quality it is very persistent and difficult to eradicate; the latter point is detrimental to its use as a crop to be taken in a rotation. When highly cultivated it yields heavily under irrigation and is grown for hay near some large stations. In 1868 there was a plot of this grass on the Farm measuring 3 acres; it yielded fairly without irrigation, and during the year 1870-71 gave five cuttings yielding 8 tons 13 cwt. of hay; this hay sold for Rs. 360-13-3, whilst the cost of curing it was Rs. 105. After this, the plot was kept for pasture, and in 1875 not half of the grass then growing was hariali, the remainder being chiefly nutt-grass (*Cyperus rotundus*) and finger-grass (*Panicum sanguinale*).

The following system is recommended for putting down this grass:—

"The land having been well cleaned, should receive a dressing of fold-yard manure. When ploughing in the manure a woman should follow each plough and drop the roots in the open furrow, the succeeding plough covering them up, when its furrow is similarly planted, and the process repeated; a heavy harrowing and rolling complete the work."

Regarding the curing of hay the following remarks with reference to this grass are of value:—

"Hariali, like most other meadow grasses, should be cut immediately the flower begins to appear; in this state the juices of the grass are more nutritious and the hay is far superior than when made from the fully matured plant. Besides, when cut before the seed appears, the plant is more vigorous and produces another crop much sooner. Hariali hay is generally spoiled in this country by being too much exposed to the sun's rays. It is quite unnecessary to bleach the grass in order to make it into hay. The great object should be to retain the green color of the grass by drying it as quickly as possible. Under ordinary circumstances, two days, or at the most three days, should suffice for making the hay.

"Cutting should not commence until the dew is off the grass. The grass should remain on the ground for an hour or so after being cut. It should then be turned and tossed until sunset. It cannot be tossed too much during a hot sun. To preserve the green color and aroma of the hay it is absolutely necessary to keep it moving. At night, if the dews are heavy, it should be put up in small cocks, each containing from two to three cwts. These cocks should not be tramped, though it is advisable to

beat the outside smooth with the back of a rake, in order that, should a shower of rain fall, the water may run off without penetrating the mass. A single hay rope should be passed over the cock to prevent it from being blown to pieces by a gust of wind. Next morning, after the dew is off the ground, the cocks may be opened again, and the hay spread out. It must be tossed and turned again as on the previous day, care being taken that it is constantly kept moving. At the end of the second day, under ordinary circumstances, it will be fit to cart, though if the weather be at all damp or foggy it will be advisable to give it another day's sunning, of course putting it again into cock at night.

"Hay thus rapidly made is rich in saccharine matters, and is, therefore, very liable to heat and ferment; this, to a moderate extent, does no harm; in fact it gives the hay a good flavor: however, care must be taken that it does not go too far and char the hay. If the hay is loose in a room, exposure for an hour or two in the hot sun will put it all right, or a layer or two of dry paddy or cholum straw may be put through the mass. In the stack it is equally easy to prevent too great fermentation. I have found a single line of six-inch drain pipes placed at about the middle of the stack from the centre to the outside, a capital arrangement for keeping down the temperature. A thick bamboo, or a couple of hollow pieces of the stems of palmyrah or cocoanut trees, the one resting on the other so as to form a pipe, will equally effect the purpose, or, in building, two or three layers of dry paddy or cholum straw placed in a stack will prevent it heating to an injurious extent."

In 1874 some experiments with indigenous grasses were made, and it was found that the following grasses, on the soil and under the conditions met with at Saidápet, gave the results mentioned.

Name of grass.	Botanical name.	Remarks.
Melampary or Pishachi.	Panicum sanguinale ...	Average height 2 feet 9 inches. Upright growth without bottom grass. When green it yields a fair fodder, but unfit for making hay.
Shegapu Shamai.	Dactyloclenium Ægyptiacum.	Average height 15 inches. Bottom grass abundant; a moderately good pasture grass; would afford a coarse hay.
Chinna Arricum.	Panicum erucœforme ...	Average height 24 inches. A fair quality bottom grass. Stems and blades fine but rather wiry. A moderately good pasture grass. Makes coarse hay.
Koopary	Panicum distachyum ...	Average height 24 inches. A coarse grass; almost useless for pasture or for making hay.
Korani	Panicum Peeticœrii ...	Average height 24 inches. Destitute of bottom grass. Affords a moderately good fodder, but unsuited for making hay.
Varashamai ...	Setaria glauca	Do. do.
Ottarai	Lappago racemosa ...	Average height 12 inches. Has an abundance of bottom grass. Is a moderately good pasture grass. Affords hay of fair quality.
Vematheriti ...	Trachys mucronata ...	Average height 30 inches. A coarse inferior grass.
Poopillu	Poa fluvialis	Average height 9 inches. A fair amount of bottom grass. Blades and stem tough and wiry.
Punjapoo ...	Cyperus iria	A useless grass.

Elephant grass.—About the year 1872 a tall, upright grass was noticed growing on the Farm amongst some paddy that had been raised from purchased seed. The grass had evidently been introduced from some distant part of the presidency, as it was unknown in the district around Saidápet. In habit of growth and in general appearance it resembles the small millet (*Panicum miliare*), but its seed is much smaller and more like that of the spiked millet. As the grass appeared to be a large producer, while the fodder seemed to possess some merits, some seed was collected and sown on a plot of land measuring 624 square yards, with the following results :—

Number of times ploughed ...	Ploughed in puddle three times.
Quantity of manure used ...	About 16 cart-loads of fold-yard manure.
Date of sowing	14th March 1873.
Quantity of seed sown ...	9 lb. of seed ; broadcast.
Date when germinated ...	20th March 1873.
Number of times weeded ...	Four times.
Do. of waterings ...	Twenty-five.
Date of first cutting ...	5th June 1873.
Weight of first cutting ...	1,576 lb.
Average height	3 feet.
Date of second cutting ...	25th September 1873.
Weight of second cutting ...	1,132 lb.
Total yield	2,708 lb. = 21,004 lb. per acre.

Attempts have often been made to introduce the grasses cultivated in Europe and America into this country, but with, in general, very partial success. On more than one occasion Prairie grass (*Bromus unioloides*), Italian rye grass (*Lolium Italicum*), Perennial rye grass (*Lolium perenne*), have been tried, and the results have been that the seeds germinated well and produced healthy plants, which, however, died off on the approach of the hot season. Greater success attended an attempt made in 1875 to introduce the Buffalo grass (*Stenotaphrum glabrum*) of Australia and America: a small box of roots was obtained from Sydney, and although six or seven weeks in transit most of them reached Madras alive. The plants grew fairly at first after their introduction, and spread over the ground, but the area planted was too small to admit of any practical conclusions being arrived at regarding the suitability of the grass for general culture here, and later experience does not seem to point to its suitability to this climate. It is said to thrive in hardened alkaline soils on which other grasses will scarcely exist; in this country we have a large area of such soils.

Guinea grass (*Panicum jumentorium*)—has, of all the grasses experimented with, been found to be the best; it is an exotic, but perfectly acclimatized grass, which is most easily propagated by root cuttings. Its culture is very simple, for, if planted at the commencement of the rains, it soon strikes root and is then safe and out of danger for the future. If planted in rows it allows of interculture by cattle-power, by which means the land on which it grows may be easily cleaned ; thus it affords an excellent crop for a rotation. It has been found capable of withstanding our longest and severest droughts without the aid of irrigation, and, although its energies remain dormant during such a time, the first rain makes it spring up again most rapidly. This power was never more clearly demonstrated than

in a field planted in September 1875, measuring about 2 acres, which in May 1877, after the great drought, was as brown and as dry as if the grass were totally devoid of life; the heavy rains which fell during that month, however, led to its immediate revival, and, before the third day of rain was over, green shoots had appeared all over the field which grew on and produced a good crop of fodder in two months, which weighed green 5,566 lb.; this was followed by another cutting of 4,564 lb. of dry fodder two months after, an amount equal to about 12,000 lb. green. Not one per cent. of the tufts failed to throw out shoots after the rain referred to.

An idea still prevails that Guinea grass must be irrigated, not only at the time it is planted, but regularly at stated intervals afterwards; that it must be taken up and be replanted on new ground at the end of every two years at the furthest, and that the fodder is not a suitable food for stock, and can only be used in small quantities for such a purpose. It is perfectly true that if Guinea grass is planted in the hot season, or during dry weather, when the soil contains scarcely a particle of moisture and the sky is clear and bright, that the plants will fail completely if not watered a few times; but there can seldom be any necessity for planting under such circumstances. In the dryest parts of the country there is always a time when the sky is cloudy and the weather showery, and, if such opportunities are properly utilized for planting, the roots can be established sufficiently well without the aid of irrigation. Irrigation, of course, enables more cuttings to be obtained in a year, but it is never necessary for the maintenance of the crop. It is, however, most necessary to manure land for Guinea grass well.

It is general on the Farm to plant this grass (the sets being obtained by dividing into several parts old tussocks from another field) on the ridge on a showery day, care being taken that they are planted uniformly at a distance of 2 feet apart in each direction, thus admitting the use of the plough between the lines of plants and across these lines at right angles; for it is advisable to pass a plough or cultivator occasionally through and across the crop, as the absorptive powers of the soil can in this way be kept up. This ploughing or cultivating should be repeated at any rate once after the removal of each cutting. Before the end of the second year the plants from frequent cutting will have formed large tussocks; these should be reduced by simple chopping with a spade, hoe, or mammotty. It has been found best to make two cuts across the tussocks at right angles to each other, thus dividing them into four parts. Of these, three may be removed, and form excellent bedding for cattle stalls, the fourth remaining to perpetuate the crop. In this way there is no necessity for removing the plants to other ground, but care must be exercised to see that the soil is properly manured, as a crop which yields such large returns necessarily makes large demands on the soil.

The fodder can be used for all kinds of stock; at first, it seems to disturb the digestive organs of some animals, but this is only temporary; cattle and sheep have been fed on it exclusively for months, not only without any ill-effects, but with the most satisfactory results. A Guinea grass field is a capital place in which to graze working cattle during the hot season, while for ewes with young lambs better pasture could scarcely be discovered. It produces an abundant flow of milk

in the ewes, without, what is common in such cases, disturbing the health of either mother or lamb. Care must, however, be always observed never to graze Guinea grass too closely.

In 1879 the seeds of a number of grasses were obtained from Queensland, several of which have done well. Amongst those which have done best are the following :—

Andropogon halepensis—grows to a height of about 6 feet and produces heavily; fodder coarse and reedy. It is not likely to be of much value where Guinea grass can be grown; withers up in the dry weather when Guinea grass under similar conditions is quite green.

Andropogon album.—Apparently a good one; produces a large number of bottom leaves even in comparatively dry weather.

Panicum Brownii—has thriven remarkably well, and will, if acclimatised, make an excellent pasture grass; seeds freely.

Festuca Billardierrii.—Stem 1 foot high, rather wiry; produces few leaves; may be useful cattle food when mixed with more tender species.

Chloris ventricosa.—Same height, but more wiry than last; produces more leaf.

Arundinella Nepalensis.—1½ feet high; produces a good deal of leaf; rather coarse.

Sporobolus elongatus.—Flat stem; rather coarse; roots ramifying greatly and well adapted to hot climate in this respect.

The following figures show the comparative return obtained from small plots (80 square yards) in the botanical gardens in 1883 with some of these grasses :—

—	Yield of fodder.	Yield per acre.
	LB.	LB.
Guinea grass	617	37,020
Andropogon halepensis ...	734	44,040
Panicum Brownii ...	422	25,420
Lemon grass	646	38,760

The *Panicum Brownii* was allowed to mature its seed before being reaped and appears to be a promising introduction.

Reana (*Euchlœna* or *Reana luxurians*).—This gigantic grass was introduced a few years ago as a fodder crop from Central America and was said to have much to recommend it. It is undoubtedly a heavy producer, but the following remarks embody the result of the experience gained with it on the Farm.

"On good soils, under liberal treatment, when it can obtain plenty of rain or irrigation water, the crop grows most rapidly and luxuriantly; but it cannot withstand a drought. Indeed, the experiments made showed that a drought which scarcely affected the sorghum crops was sufficient to check the growth of the Reana to such an extent as to render it useless to keep the crop standing longer. As a fodder crop, in a damp warm climate, or where irrigation can be secured, it is well worthy of attention. There is perhaps no other crop, sugar-cane excepted, which will produce such an enormous quantity of green plant per acre, but the fodder is very watery,

and does not appear to be very palatable to stock when offered for the first time. The watery juices of the stem seem to be destitute of saccharine matter during all stages of growth."

When yellow cholum is grown under the very favorable conditions needed to secure a fair crop of Reana, it will yield very heavily and produce a far superior fodder to Reana, while a good crop of yellow cholum fodder may be produced under conditions in which the Reana would utterly fail.

The following experiments were made in order to determine the best means of preparing the seed of this plant as food for stock. The results, it will be observed, were discouraging:—

"(1.) A quantity of the grain was placed in cold water and allowed to soak for 56 hours. At the end of this time the grain was almost as hard as when first placed in water, while it had increased only about 10 per cent. in volume.

(2.) Half a measure of the grain was boiled for $6\frac{1}{2}$ hours. At the end of this time the shell was perfectly hard, though the inner portion was soft; still it was quite impossible that the grain could be masticated by any animal. After boiling, the grain measured $6\frac{1}{2}$ ollocks, which was an increase of 62 per cent. It appeared to be useless to continue the boiling process longer. The boiled grain, when cold, was offered to several sheep, all of which refused to eat it.

(3.) Half a measure of the grain was placed in a stone mortar and was beaten for two hours with a heavy pestle, but none of the grain was crushed.

(4.) Half a measure of the grain was placed in a powerful corn-crushing mill. The grain in passing through the mill was partly crushed, but only very imperfectly, and it was necessary to pass it seven times through the mill to get the grain powdered; and this was only a rough coarse powder. This powdered grain was offered to a number of sheep, but again it was refused."

Prickly Comfrey (*Symphytum asperrimum*)—has been strongly recommended for culture as a fodder plant in India, but in experiments made at Sâidápet it has been found that it has little, if anything, to recommend it for cultivation for such purposes in the plains of Southern India. It requires a deep, rich, moist soil under shade, and where these requisites can be secured, may perhaps be grown with some success, whilst our ordinary forage crops will yield good returns under much more unfavorable conditions, as has been repeatedly shown in the many results obtained on the Farm.

Salt-bush.—In 1882 attention was drawn to this plant as one that might be raised on salt lands as serviceable fodder. Several different varieties have been obtained from Australia, and the following note on the growth of one in the botanical gardens represents the general result.

"*Atriplex nummularia.*—Introduced in 1882; growth poor; plants about 9 inches high and inclined to seed."

Obione Konigii (Tamil *Avalkiré*).—This plant was found growing on the salt-beds near Ennore, and may be of value as a fodder plant on similar land elsewhere.

HORSE-GRAM—is a plant belonging to the natural order Leguminosæ. It is a hardy plant, thriving on the poorest soils. The soils of

this district contain a very small proportion of lime; and this plant, like all leguminous plants, requires a good deal of lime before it can mature its seed. It has been ascertained from experiment that, unless the manure applied contains a considerable percentage of lime, the tendency of the plant under good cultivation is to produce leaf rather than seed; this tendency has been utilized, and by deeper cultivation and the application of a moderate dressing of manure we have succeeded in growing good fodder at a very moderate cost.

Generally in preparing land for gram the following method is adopted:—After ploughing 4 to 6 inches deep and harrowing, the seed is sown in lines—if the season is unfavorable and the soil poor, close together; if the reverse, far apart—at the rate of from 30 to 40 lb. per acre. During growth, the crop is bullock-hoed once or twice, as circumstances demand, and hand-hoed at least once. The crop should be cut immediately the flower appears and removed the same day. The cost of growing a ton of fodder is about Rs. 3. The fodder makes good hay, which possesses a pleasant aromatic smell when well made; it, however, loses 75 per cent. of its weight in curing.

When cut before maturing its seed, the cultivation of gram improves rather than impoverishes the soil. There will always be a slight loss in the mineral constituents; but still, as the plant appropriates such a large amount of atmospheric food, and stores it away in its roots, and as these roots, weighing from 800 to 1,000 lb. per acre, are left in the soil, its condition must be greatly improved.

The value of the crop for green manuring has been, and the nutritive quality it possesses will be, referred to in another place. If grown solely for fodder four or five crops may be produced in a year, and thus the crop is admirably adapted for renovating worn out or improving poor lands. The following extract from the report for 1883-84 is of interest in this respect.

"It is a practice on the Farm to sow this crop for fodder, or use as a green manure, on paddy land immediately after reaping the cold-weather paddy crops, if a second crop of paddy cannot be raised. The small quantity of moisture present in the land at the time of harvest is generally enough to start the crops, which are found to give a fair outturn of fodder, though there may be no rain whatever during their growth. The advantage of this system is that the land is made use of and kept under tillage during the dry season. The following statement shows the extent to which horse-gram was raised in the early part of the year and the outturn:—

Field.	Area.	Date of sowing.	Date of harvest.	Duration of growth.	Outturn.
	ACRES.			DAYS.	LB.
22	1·63	3rd March 1883 ...	4th May 1883 ...	63	1,835
28-C	·99	10th March 1883 ...	22nd May 1883...	74	920
30-A	2·05	28th February 1883...	14th May 1883 ..	76	3,685
34-B	·77	28th February 1883...	5th May 1883 ...	76	730
35-B	·61	26th February 1883...	8th May 1883. ...	72	816
36	2·94	6th March 1883 ...	2nd June 1883...	89	3,656
37	·45	7th March 1883 ...	26th May 1883...	81	1,520
Total ...	9·44				13,162

"No rain fell during the growth of any of these crops.

"It will be seen that about six tons of green fodder, worth about Rs. 48, were obtained without any rain whatever between March and May. If paddy is harvested in January or February, as it usually can be, the outturn would be still more satisfactory, as the land would then always be moist enough to give a good start to the crops. This practice is worth imitation by the ryots, being very simple and inexpensive."

A peculiarity regarding the seeds of this crop is noticeable, and that is, the time they may lie dormant in the soil and yet germinate afterwards under favorable conditions. Seeds have been known to lie on a dry open soil for two or three months and then on a fall of rain occurring, suddenly to spring to life. A great many seeds exposed in this way would be destroyed.

The other common pulses, Green gram (*Phaseolus Mungo*), Black gram (*Phaseolus Roxburghii*), Dew gram (*Phaseolus* ?) have all been grown on the Farm from time to time, but they do not generally produce much seed as the soil is probably deficient in lime; but on referring to the table given at page 150 it will be seen that they, especially the last-named, are capable of producing large crops of fodder. The pigeon pea (*Cajanus Indicus*) has also been frequently grown, but it also does not seed well. It has been tried and found useful as a shade plant amongst casuarinas. Bengal-gram (*Cicer arietinum*) has been tested on a small scale, but the results were not such as to induce the extension of its cultivation on the Farm.

Wild indigo (*Indigofera paucifolia*) has been grown on a small scale for fodder with satisfactory results. Sheep are very fond of it, and it grows very freely on our poorest soils, keeping green during nearly the whole of the year, and may possibly become a valuable crop.

Lucerne (*Medicago sativa*).—Under irrigation this plant produces a large quantity of valuable fodder. A few pounds of English seed sown in September 1869 grew satisfactorily and yielded three cuttings of excellent fodder; it did not appear to be injured by the heat of the sun, though the thermometer exposed in the sun part of the time registered 135°, and the crop then looked vigorous and healthy. A similar result was obtained with some seed sown in 1876.

THE SOY BEAN (*Glycine Soja; Soja hispida*).—Some seed of this, the China bean, a plant largely cultivated in China and Japan, was obtained in 1882. The bean affords a valuable oil, and the residue, after crushing, a valuable cattle food, while the green pod is made into the well-known sauce. It arrived safely, and on the 4th January 1882 a plot of 72 square yards was planted with the seed. It germinated well and produced healthy plants, but only about 1½ feet in height, some of which were well covered with pods, though the majority did not thrive, apparently owing to the excessive heat of the weather at the time. Of course, it was a far from favorable time of the year at which to sow the crop, but it was thought better to sow the seed with the chances of adverse weather, rather than to keep it over until the following cold season, as experience has shown that the larger leguminous seeds lose their vitality very readily when exposed to a high temperature. The crop was gathered in April 1882; the yield per acre was 280 lb. only.

The plant and seed resembled mochacottay (*Lablab vulgare*) considerably, but it grows more uprightly, and the leaf is slightly different, while it has no tendrils. The following statement shows the differences between them :—

Lablab vulgare.—Larger plant, less hairy than *Glycine Soja*, twining. Pods horizontal, broadly scimitar-shaped, gibbous below apex, and ending abruptly in a straight or recurved cuspidate point. 3 to 5-seeded seed, with raphe very marked. Seed larger, longitudinally oval, compressed.

Glycine Soja.—Plant small, no twining. Leaves *very hairy*, small. Pods pendulous, narrower, 2-seeded, often 3-seeded. Seeds smaller, inclined to be round, raphe indistinct.

The following analysis, published by the Society of Arts, shows that the bean is a very nutritious one :—

Water	15·20	per cent.
Fat	16·21	" "
Protein compounds	28·63	" "
Non-nitrogenous extractive matter ...	30·84	" "
Fibre	4·38	" "
Mineral matter	4·74	" "
Total ...	100·00	

It would be a very great advantage in this part of India if a good variety of bean could be introduced into general cultivation for human food. The people of South India depend largely on a vegetable diet, generally of a very inferior kind, and the addition of a good pulse to their daily food would go a long way towards supplying the albumenoids which they so greatly require, and which they at present get in such small quantities.

Indigo (*Indigofera tinctoria*).—The growth of this valuable crop is attended with considerable difficulties. The seed time adopted on this Farm is usually characterised by very uncertain weather, and the difficulty in obtaining as good a seed-bed as is requisite is great, whilst the chance of a heavy fall of rain caking the surface of the ground, and thus preventing the young germs from coming through, is considerable; but, when once a fair plant is obtained, we have scarcely any crop more hardy and less susceptible of drought. Land intended for indigo should be broken up well in September, or earlier if possible, and at some convenient time it should be ploughed and subsoiled as deeply as possible. Every exertion must be made to remove weeds, especially those of a rapid habit of growth, for indigo, when it first appears above the ground, being a very small and tender seedling, requires to have the fullest and freest liberty in order that it may get beyond that stage as rapidly as possible. Shortly before sowing, the surface soil must be brought into as fine a tilth as is possible, such as is desired for turnips in England; this can generally be attained without much difficulty, unless very wet weather prevails, by the aid of those processes which the agriculturist knows how and when to make use of, such as ploughings, rollings, and harrowings. When the requisite degree of fineness has been obtained, the surface

should be rolled down in order to render it sufficiently compact and even to prevent the seed, which should always be sown in lines to admit of interculture, from being buried too deeply; in fact probably half an inch deep is amply sufficient for so small a seed, and, were it not that the sun is, whenever it appears, so powerful, scorching, and destructive to young plants, it might be sown with advantage on the surface and only covered, as clover is, with a brush harrow.

From 10 to 15 lb. of seed should be sown per acre, but even less will do if the seed is of first-rate quality, and than indigo there is perhaps no crop the seed for which should be more carefully tested with regard to its vitality. Fresh seed carefully harvested from the first growth, not the last as is the common practice in this country, should always be used. In some cases it may be useful to steep the seed before sowing.

Having sown the seed with every precaution to ensure its early and regular germination, the appearance of the plant above ground must be awaited; this is perhaps the most anxious period of the crop's existence, for should heavy rain fall, in all probability the sowing will be lost, even if the germs have just penetrated the surface. Should, however, success reward the endeavours of the cultivator, and the plant come up evenly over the whole field, nothing can be done until it has grown to such a size as will enable the lines to be discerned; to expedite this, if there be any grass in a field, it has been found useful to turn a flock of sheep in, which will graze down the grass, leaving the young indigo intact, and thus allowing the bullock-hoes to be admitted some days earlier than otherwise. Following in the wake of the bullock-hoes, hand-hoes should be kept constantly at work, and, when their work is finished, in all probability—unless the land be in a very foul state—the field can be left until the crop is ready to yield its first cutting.

If the sowing takes place at about the middle of November the crop will be ready for cutting by the beginning of March; after this cutting is removed the crop should be bullock and hand-hoed, and in a good season a second cutting can be obtained in May, followed by a third in July; between the last two cuttings the same cultivation being performed as after the first. In a fair season, on average soil, a yield of 200 bundles measured with a seven foot chain may be expected per acre; this would be worth at present rates nearly Rs. 30, whilst it may yield to the manufacturer 2 maunds of dye, if the indigo be good, worth about Rs. 90, at a very small charge for manufacture. It is well known that the ryot gets but a small share of the profits of the crop; probably he scarcely makes one-tenth of that which goes into the manufacturer's hands.

A crop of indigo yielding 200 bundles per acre will weigh about 12,000 lb.*; this amount of valuable organic substance can be recovered *in toto* for use as manure from the vat after the dye has been extracted. Estimating this to be worth Rs. 3 per ton, we should get per acre manure in the shape of compost of a total value of Rs. 16, and thus indigo would become a restorative crop, and not, as it is now, where the plant is wasted, one of the most exhausting grown by the ryot. The valuable characteristics of the indigo crop do not,

* A single cutting has given as much as 11,040 lb. per acre.

however, alone consist in the valuable compost it gives, for the roots, &c., left in the soil after the last cutting form a most useful preparation for a cereal crop, which should be taken next.

The value of the water used in steeping the plant for irrigation purposes is also great, containing as it does a considerable amount of the valuable ash constituents of the plant, and a considerable quantity of nitrogen. Indigo has been tried more often with failure than success, and the remuneration, which has been shown may be derived from its cultivation, may be pronounced exaggerated; such an idea, however, would be based on deductions derived from the wasteful, irrational, and suicidal practices usually pursued, and until they are corrected indigo will continue to retain the evil character it at present possesses. There are risks attending its culture, but large profits may be expected from it, and these far more than compensate for any danger which may be incurred.

Tobacco—has been cultivated on two occasions on the Farm, first in 1871-72, and again during the years 1878-79-80, on a more extensive scale, and the following advice to growers has been deduced from the results of these experiments. To raise plants for an acre of land, select as a seed bed a healthy piece of ground measuring about 100 square feet, the soil of which should be friable (a sandy loam or loam), and well drained. Dig the ground over to a depth of 1½ feet some months, and a second time about two weeks, before sowing the seed, and manure it heavily; if the soil is poor as much as a country cart-load of well-rotted manure (about 600 lb.) may be given; and shortly before sowing the seed dig over the ground a third time. Divide the nursery into three beds; each bed should not be more than 4 feet wide to facilitate watering, &c. Sow the three beds at intervals of four or five days; by this arrangement ample time will be given to transplant the seedlings when ready. The best time for sowing is immediately after the monsoon rains are over, and about one ounce of good seed is sufficient to raise as many seedlings as are required to plant one acre; therefore one third of that amount of seed will be required for each division of the nursery. The soil having been reduced to a fine tilth, sow the seed broadcast on the surface and cover it by strewing some handfuls of mould or fine compost manure over it, taking care not to bury the seed deeply but only to cover it; if ants are troublesome, strew some ashes over the surface to prevent their removing or injuring the seed. A temporary shed, or a roof of calico, should be erected over the nursery to protect it from sun and rain, and a deep drain dug around the beds to avoid excessive wetness of the soil. After the seed is sown keep the soil constantly moist, but not wet. During dry weather it will be necessary to water the beds two or three times daily for the first few weeks; this should be done with a watering pot with a rose, the pot being held low when watering, for otherwise the plants, which appear about eight days after sowing, and are very tender during the first stage of their growth, may be destroyed. Should the plants spring up very thickly they must be thinned out when about a week old, and may be transplanted either into a separate bed or into another part of the same bed, when blanks exist; each plant should be allowed not less than one square inch. The seedlings will be fit for transplanting about six or eight weeks after sowing.

The land intended to be planted with tobacco should be situated if possible near to the nursery bed; the soil preferably should be of the same quality as the nursery bed, viz., a friable sandy loam or loam, with adequate drainage; clay soils usually produce heavier crops, but the leaves are generally coarser and do not possess so much flavor after being cured. After being several times deeply ploughed, the land should be heavily manured and again ploughed and harrowed until the soil has been reduced to a fine tilth, and then it should be ridged. The distance apart at which to place the ridges depends on the nature of the soil and the species of the crop. With a good species, such as the Maryland, which grows to a considerable height and spreads its leaves very much, on a good soil the ridges should not be less than 3½ feet apart from centre to centre, to allow weeding, hoeing, suckering, &c., without breaking the leaves. In the lines the seedlings may be planted about 3 feet apart. Transplanting should be performed only in the evening, excepting on cloudy days, when it may be done at any time. Before lifting the seedlings, the nursery bed should be properly watered in order that the plants can be easily removed without breaking their roots. The plants must be watered immediately after transplanting and the watering must be repeated every day for about a week unless rain falls; the plants should also be shaded during this time to protect them from the sun, and blanks caused by the death of any plants must be filled up from the nursery.

After the plants have once taken root they grow rapidly and require comparatively little attention until they commence to flower. They will require a watering once in from four to eight days according to circumstances, and hoeing whenever the soil becomes too close and weeds make their appearance. Insects, which sometimes attack tobacco, must be searched for and killed. When the plants are about nine inches to a foot high, the soil should be heaped round them in cones and saltpetre should be applied unless the soil be very rich in potash. 200 lb. of saltpetre per acre produced a notable effect on the tobacco grown on this Farm; the saltpetre was applied after being dissolved, holes being made near the stem of the plant and a certain quantity of the solution poured into them.

The plants will commence to flower about two months after transplanting, when about 3 to 6 feet high. As soon as the flowers appear they must be broken off together with the top and bottom leaves. The suckers, which appear after the tops have been broken off, must be removed at least once every week, for if this is not done the quality of the tobacco and the size of the leaves will be seriously impaired. The crop will be fit for cutting about three months after transplanting. Proper maturity is indicated by the appearance of yellow spots on the leaves; at which time they become very brittle.

When the plant is fit for harvest, the whole should be cut down at the bottom and removed at once. It should then be hung up, tying the butt-ends of two plants together, over bamboos, &c., under some shade for wilting; any large tree standing near will answer the purpose, or, if none be available, a temporary shed should be erected near the field. The plants should be handled as little as possible in order to avoid breaking their leaves. After being wilted they must be removed to a curing shed and hung close together until the

leaves have commenced to turn yellow, when they must be hung wider apart to avoid injurious decomposition, and may remain thus until quite dry and fit for stripping. The time required before the leaf is fit for stripping varies from four to six weeks according to the weather. If the air be very dry, it may be necessary to pour some water on the floor of the shed to make the leaves more pliable ; if the air be moist the leaves are apt to become mouldy, should this happen a fire must be made to promote the drying of the leaves.

Whilst stripping them, the leaves should be sorted according to quality; the best colored (golden) and large sized leaves give cigar wrappers and will fetch the highest price. After stripping they should be piled in heaps to undergo a further fermentation : when the heat rises too high, viz., to more than 110°, the tobacco must be re-piled, but a well-dried tobacco will seldom heat as much. Tobacco may be kept in bulk for some months, after which it may be made into cigars or disposed of otherwise.

In 1878 several varieties of tobacco were experimented with ; viz.,

An Italian variety of the Maryland (*macrophylla*) species.
The Madura variety, apparently of the Virginia species.
Kistna Lunka do. do. do.

The first grew luxuriantly to a very great height and produced very large, thin leaves of fine quality; the second produced very long (some 2¾ ft.) and pointed leaves ; and the Lunka variety very large, much warped, gummy, thick and coarse leaves.

In the following year the experiments were repeated with the same and some other varieties.

The *macrophylla* species has been raised on the Farm at three different seasons, and has always succeeded, showing thereby that it is well adapted for the conditions met with, and as it yields a good tobacco and produces heavily it should be extensively cultivated. The same must be said of Kentucky tobacco, which has been grown both during the cold and the hot season. Next to these two varieties comes the tobacco raised from Madura seed. As regards the suitability of the Havanna, White-stem, and Virginia varieties, an unsuccessful first attempt cannot decide the question ; some more experiments will be necessary. Trichinopoly tobacco (a Virginia variety) succeeded tolerably well, but as the leaves are very narrow and therefore not well suited for covering leaves for cigars, this variety does not deserve much attention.

In the 1879 experiment, it was clearly shown that heavy crops of tobacco can be raised on the Farm, and the latest experiments also showed that when tobacco is grown during the cold season irrigation may be entirely dispensed with, thereby not only reducing the cost of cultivation but enhancing the outturn, because the soil remains more open and friable and produces a finer tobacco when thus treated than when the soil has assumed a close texture from frequent irrigation.

It has been found, however, that on the Farm soils it will be almost impossible to raise tobacco fit for the European market profitably. On the proportion of organic salts of potash in the leaf the "whiteness and permanency of the ash of a cigar depend," and their presence also "modifies the burning of tobacco in a peculiar way, to the improve-

ment of its flavor, and also positively facilitates burning." In real Manilla tobacco the amount of these substances is above 9 per cent., whilst the ash of the best American tobaccos often contains from 25 to 35 per cent.

The following analyses of tobacco raised on the Farm in 1879 are instructive in this point, it being noted that some tobacco raised in 1871 only showed 0·6 to 0·67 per cent. of carbonate of potash in the ash.

No.	Growth and treatment.	Analysis.		
		Percentage of ash.	Percentage of carbonate of potash in ash.	Percentage of nicotine.
1	Grown in Botanical Garden, manured with horse manure at the rate of 20 tons per acre, occasionally irrigated, and cured after American fashion	20·5	4·916	1·57
2	Grown in Botanical Garden, manured with lime at the rate of 8 tons per acre, cured like No. 1	19·40	3·323	1·62
3	Grown in Botanical Garden, manured with bone-charcoal at the rate of 6 tons per acre, cured like No. 1.	22·85	4·938	4·08
4	Grown in Botanical Garden, manured with ashes at the rate of 21 tons per acre, cured like No. 1	21·60	3·083	2·26
5	Grown in field No. 4, raised without manure or irrigation, cured like No. 1	19·65	3·395	2·31
6	Grown in field No. 4; grown without manure or without irrigation, cured according to country fashion	20·60	3·802	1·94
7	Tobacco, 20 plants raised in field No. 4 without manure or irrigation, cured according to American fashion...	24·00	4·169	1·5
8	Grown in field No. 8, previous year, cured like No. 1 ...	21·75	3·433	2·04
9	Grown in field No. 8, previous year, cured like No. 1, but afterwards steeped in diluted HCl and jaggery water at the rate of 8 oz. of HCl and 1¼ viss of jaggery per 100 lb. of tobacco	22·85	4·808	3·12

These results afford a great contrast to those obtained in 1871 and show how much the Farm soils must have been improved by careful cultivation; but even with this, although it has been possible to raise and cure fairly leaf even in color and of good odour, the tobacco grown in 1879 possessed the fatal characters (for a tobacco) of burning slowly, not keeping a light well, and yielding a black ash. These characters were probably due to the small amount of potash salts present. It will be noticed that, even where a very large quantity of ashes, which would contain a large proportion of potash salts, were applied, the percentage of carbonate of potash in the ash of the tobacco was under 4 per cent. It is a matter of surprise that horse-manure should not have produced a leaf containing more nicotine; probably, however, much of the nitrogenous matter of the manure had been lost; it was old manure from the Artillery stables. The bone-charcoal used contained, when analyzed, 57·5 per cent. of phosphate of lime.

Oil seeds—have not received very much attention, although undoubtedly their growth is one which should be encouraged, and the introduction of superior varieties of those commonly grown is much to be desired.

The Castor-oil plant.—Through the courtesy of Professor I. Giglioli, M.R.A.C., of the Royal High School of Agriculture, Portici, Naples, seeds of the following varieties of this plant were received from Italy in 1877 :—

Ricinus communis.	Ricinus communis cyclonthe.
,, ,, herbaceum.	,, microstatum.
,, ,, Cuban.	,, miscrospermum.
,, ,, utilosus.	,, purpureum.
,, ,, spectalite.	

They were sown on the 16th January 1878. Nearly all the seeds germinated and the plants appeared above ground on the 24th. The plants all grew very vigorously and some of them attained a height of 10 feet in a short time. Only a few seeds having been received, the seed of all varieties was sown in one division of the garden; the different varieties consequently grew in proximity to each other. Of each variety, 2—6 plants were raised, except of *Ricinus mycrospermum*, which is the medicinal castor-oil plant, of which 14 plants were raised. The plants flowered and produced seed nearly throughout the year; some of them yielding very well. Of the species *Ricinus purpureum* two plants were raised; both trees grew to a great height; they were very ornamental, being profusely covered with leaves and flowering and bearing continually, and would make a very good shrub for gardens. These two trees were in appearance alike, but the seed differed very much; the beans of the one tree being much larger than that of the other. The produce of one of the trees amounted to 15 lb. of beans during the year.

It would appear that all the plants hybridized except the *Ricinus mycrospermum*, as none of the seeds of two trees were exactly alike. The *Ricinus mycrospermum*, it would appear, did not hybridize on account of the characters of the plant being more distinct from the other varieties than those of the remaining varieties between themselves. Both the seed of *Ricinus mycrospermum*, and the plant, varies very much from the other varieties; the color of the plant and the leaves is a light green; the whole tree has the appearance of an umbelliferous plant growing in a globular form, which habit gives it a nice appearance.

From hybridization and other causes the seed became much mixed. In 1879, No. 13 field, which measures 2·73 acres, was sown with seed of these several varieties: but though the results shown in the following table were obtained, it was impossible to trace the varieties referred to. The results in several cases were very good. A full record is not available, but the general results were as follow :—

Plot	1	2	3	4	5	6
Area in acres	·57	·57	·42	·41	·41	·25
Seed sown ... ... lb.	7	6	4	2·5	2	1
Seed per acre ... lb.	12·5	10·5	9·5	6	5	4
Yield ... ... lb.	161	489	125	260	195	18
Yield per acre ... lb.	282	858	293	634	475	72

The outturn from the last plots was affected by the inferiority of the soil of the part of the field where they were situated.

In 1881 again some more small packets of the seed of this plant were received from the same source, and the following notes refer to the plants raised therefrom.

"The seeds were sown in pots on the 5th March 1881; they germinated very well; the seedlings were transplanted on the 11th April 1881 into beds prepared to receive them.

"*Ricinus communis* var. *Armatus.*—At the close of the year only three plants of this variety were living. This is an annual; grows to a height of six feet; it has too many side branches. The spikes are short and the capsules are of medium size; only four ounces of the seed were collected.

"*Sollingeri.*—Two plants only are living; they grew to a height of five feet. This variety seems to be an annual. The spikes are short but the capsules are large. The plants have not borne well; only two ounces of seed were collected.

"*Arcuatus.*—The plants were healthy and robust in the cold season, but died when the hot weather set in; the growth is bushy. The spikes are long and the capsules are of a medium size.

"*Rugosus chuveanus.*—Three plants of this variety are in the bed; they thrive well even during dry weather; they have grown to a height of 20 feet with a stem girth of 10 inches in 12 months. They bear well. The spikes are long and capsules closely attached to the stalk and of a good size. Some seed of this variety was collected and sown in another bed, where it has thriven even better.

"*Subrisides.*—The plants grew to a height of 10 feet with a stem girth of 8 inches. The spikes are long but the capsules are very small."

Gingelly—has been frequently grown and the following remarks regarding the crops raised in 1879-80 indicate most of the information obtained regarding it:—

"The *gingelly* crop may be divided into two portions: the hot-weather crop, occupying an area of 21·29 acres and yielding on the average 78 lb. of seed per acre; and the cold-weather crop, which occupied 7·76 acres and the average outturn recorded being 222 lb. of seed per acre. The hot-weather crop suffered during July, as has already been explained, which chiefly accounts for the low outturn recorded, but to some extent it is also attributable to the bad weather experienced after harvesting, which necessitated frequent turning of the plants in the yard to dry them, during which much of the seed was shed and a good deal became mouldy and valueless. Gingelly is always a difficult crop to harvest in unsettled weather as the seed is so easily injured. Crops Nos. 10—14 were raised on ordinary paddy land irrigable from the Mylapore Tank; the soil of all the fields (except 36, which is very poor and sour) is a sandy loam in tolerably good manural condition. The crops suffered from the dry weather of July and the outturn was nearly every where very low from the causes referred to above; however, the outturn of 144 lb. per acre in field No. 35-IV is not bad, considering the conditions the crop had to contend with.

"The cold-weather crops, Nos. 15—20, were the first of this crop raised during this part of the year. They were sown very late, in fact after the usual season for sowing cold-weather crops, in alternate double lines with gram; when the crop was put down, the chief object of sowing a mixture of seeds was to avoid the risk of total failure which might attend a single crop,

especially as the season was too far advanced to admit of sowing any later crop; however, as both crops grew very well, both were left to mature. The crops varied, as might be expected, with the varied conditions of the soil. In the loamy and more fertile portions the gingelly predominated, and on the sandy portions where gingelly had less chance, the gram grew well. The experiment was on the whole very successful; not only did the gingelly grow very well in most instances, but it was also not directly manured nor even hoed; the only operation performed during the growth of the crop was harrowing several times across the lines for the purpose of breaking the crust and loosening the soil and to thin out the plants which had sprung up rather thickly owing to the large amount of seed used. The harvesting was much easier than that of the hot-weather crop, for the weather was settled and dry; whilst at the time when the latter is being harvested, which is generally in August or September, there is generally great pressure of work, it being the time for putting down the cold-weather crops, and, as the weather is then generally showery, much of the gingelly either becomes mouldy or is entirely spoiled. In this case the crop was harvested at the end of March and the commencement of April; and the season being very favorable, the cost of preparing the seed for sale was very low: all that was necessary was simple turning of the plants over several times in the open yard, by which means all the seed was shed and then only required to be winnowed. The seed raised at this season was sold easily and more advantageously than that obtained from the hot-weather crop. The outturn per acre was in some instances very good; field No. 34-1 yielded at the rate of 511 lb. per acre, a very good crop; it followed a crop of indigo. The lowest outturn was obtained from field No. 21, the yield being only 98 lb. per acre; the soil in this field is chiefly sand and is in very low manural condition. The gingelly had not much chance of thriving under these conditions, but the gram raised with it was a very good crop, yielding more than 16,000 lb. of fodder per acre."

Ground-nuts.—On two or three occasions small plots have been planted with ground-nuts, but the results obtained have been unsatisfactory; there was always an abundance of leaf and stem, but the yield of nuts was exceedingly small. This is probably due to a deficiency of lime in the Farm soil; for in an experiment made in 1876, it was found that a dressing of lime caused an increase in outturn of 83 per cent. of nuts and 10 per cent. of straw.

The crop requires a porous healthy soil, rich in potash, lime, &c., and as generally cultivated is a very exhausting one, which, when frequently repeated, rapidly reduces the fertility of a soil; however, if the cake, made from the crushed nuts in extracting the oil, is given to the live stock on the Farm on which the nuts are raised, there will be but a small loss of fertilizing matters. Usually, the ryot sells the whole of the nuts he produces, and never gets back the cake for feeding his stock. The result of this is that the soils on which the ground-nut is cultivated are becoming poorer and poorer every year, and the fertilizing matters which they lose being turned to good account in the coffee estates of this country and Ceylon, and in England and France, to which countries the ground-nut is now largely exported.

Cotton.—When cotton culture was first attempted on the Farm, it was believed by most people that the experiment could yield no good results, as it was said that it had been ascertained beyond all doubt that the climate of the district was altogether unsuited for the healthy growth of the plant, while general experience had proved in an equally conclu-

sive way that cotton could not be raised on a poor sandy soil such as that which occupies so considerable a proportion of the Farm. The Collector of Chingleput, in a report to the Board of Revenue, dated 7th June 1869, explaining why he had failed in getting any cultivator to take some cotton seed which had been sent to his office for distribution, remarked: "Due notice was given in the District Gazette, and the various farmers and proprietors were invited to apply for the seed, but no applications were received, the fact being that in this district little or no cotton is grown, the soil being quite unfitted for it." Again the Honorary Secretary to the Farm Committee, in a report dated 23rd June 1869, explaining to the Board of Revenue why certain cotton seed sent by the Board of experimental cultivation had not been sown, said: "The soil of the Government Experimental Farm at Saidápet is of a very sandy description, and the Committee considered it was useless to try the experiment of growing cotton." Evidently far too great trust was placed in the opinions expressed by the ryots of the neighbourhood. On comparing the meteorological registrations of the district with those of the regular cotton-growing districts, it was found that there was nothing in the climate prejudicial to the growth of cotton, while the soil, though very much inferior to the so-called cotton soils, could, it was known, by the aid of manure be rendered sufficiently fertile.

It is true that on inferior soils such as those of the Farm cotton cannot be raised without the aid of manure, whereas, on the more fertile soils of the districts in which cotton is commonly grown, it can be; but there the yield is always very small, and indeed is seldom more than one-fourth the quantity that could be raised on the same soil if properly cultivated and manured. On the Farm, crops that have yielded 150 to 180 lb. of clean cotton per acre have repeatedly been produced, while the average produce in the cotton districts is only 75 lb. of clean cotton per acre. There are thousands of acres of land around Madras in no way inferior to the soils of the Farm, now lying bare during two-thirds of the year, and during the remainder producing wretched crops of varagoo and horsegram, which might be made to yield remunerative returns under cotton; the extra expense on cultivation and manure would be more than counterbalanced by the smaller cost of conveying the cotton to the shipping port.

Experiments were made on a small scale at first, but with uniformly successful results, and now cotton has become a regular crop.

New Orleans Cotton (*Gossypium hirsutum*) is the variety now preferred and is the one chiefly grown on the Farm. It is especially suited for high cultivation. A dressing of manure that is necessary to render our inferior soils fit for producing this cotton makes plants of the indigenous varieties run to stem and leaf instead of increasing the yield, whereas the yield of the New Orleans plant under similar circumstances is largely increased. Unless this variety is well cultivated it will not produce good results; this explains the numerous failures which have attended attempts at its general introduction. When the system of agriculture has been improved, then improved types of plants may be safely introduced. In America, the New Orleans plant comes to maturity more quickly than it does in this country; to some extent this is due to the different climatic conditions

it has to encounter in the two countries, the temperature of Madras being much higher than that of New Orleans, whilst in New Orleans the temperature in December sinks below the freezing point, which of course puts a stop to all vegetation. In New Orleans, the producing capabilities of the cotton plant are therefore more concentrated, from the shorter season in which the plant bears; in Madras, on the other hand, we have no such complete cessation of vegetable energy, excepting during an unusually long drought, and even then cotton does not perish; thus, we have no definite harvest time for our cotton, a gathering being afforded after every fall of rain succeeded by bright hot weather.

Referring to a shipment of three bales of cotton of this variety made in 1873, a firm of professional brokers in London remarked:—

"We have carefully examined the sample of three bales cotton ex *Sultan* at Madras, and find it to be of a useful description of Salem character, ginned, fair color, silky, but rather weak staple, and worth about $6\frac{5}{8}d.$ per lb.

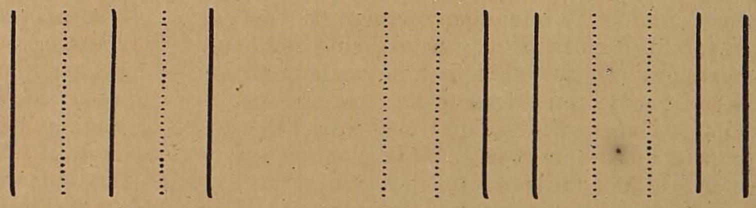
"This is the value which cotton of this quality would command to-day were it here in any quantity, say, 50 or 100 bales. The color is good and the cotton is clean, but our brokers complain that the staple has been somewhat injured; they presume in the process of ginning."

Compared with the prevailing rates the valuation was satisfactory; at the same time Fair Westerns were selling at 6*d.* per lb.

The usual system in the early years of the Farm was to sow the crop in September on land prepared in the ordinary way for maize, viz.: first, well ploughed; then harrowed, rolled, and weeded, &c.; afterwards ridged at distances of two feet apart, and farm-yard manure applied in the furrows between these ridges at the rate of 20 loads, or about 8 tons per acre; the ridges split through the centre with a plough, one-half being cast over the manure on either side, thus raising new ridges; the ridges harrowed with the chain harrow to consolidate them, and maize and cotton sown along their tops in alternate rows; the chain harrow following completed the work.

In 1880, however, an experiment in altering this arrangement was made. It appeared likely to be more convenient if the cotton plants were grown more closely together, but with greater intervals between the rows; thus in the diagram below the dotted lines indicate the rows of the cereal crop and the plain ones those of cotton plants:—

The Old Plan. The New Plan.

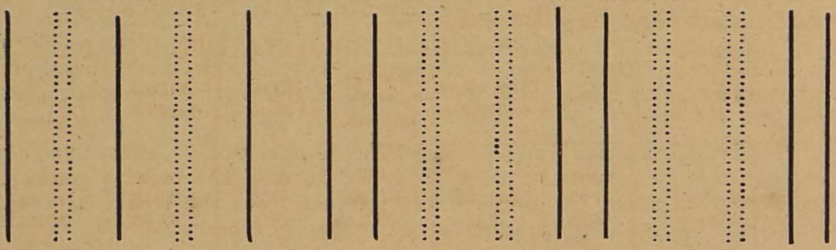


The distance between the rows of cotton in the old plan being 4 feet, and in the proposed alternately 2 feet and 6 feet, so that the same number of rows would be sown on either system in a given area. The presumed advantages in favor of the new system were, that it would

render the work of keeping the cotton-field clean, after the removal of the cereal, cheaper and more easy, and that both the cotton and the cereal would thrive better.

No. 18 field having been selected was manured heavily in June with village sweepings, at the rate of about 50 loads per acre; the manure was of poor quality, but not costly. Horsegram was then sown, which was ploughed in green at the end of August, the crop being a small one. The field was then prepared for sowing, and cotton and planter's friend were sown on 16th September on the flat in two plots on the system shown below, the lines being used to designate the different crops as has been done above:—

North Plot. South Plot.



In the north plot the lines of cotton were regularly 4 feet apart, with a double row of planter's friend between each, the two rows of the cereal being 5 inches apart. In the south plot the lines of cotton were alternately $5\frac{3}{4}$ feet and 2 feet apart, and the cereal in two double rows between the double rows of cotton with a space of 33 inches between them. It will be noticed that there is a slight variation from the plan before sketched; that regarding the position of the cotton rows was made for convenience in sowing, our seed-drill being 5 feet 9 inches wide, and that regarding the cereal, from error; the variations, however, do not materially affect the results.

The outturn obtained is shown below, the plots being of equal area.

		North Plot.	*South Plot.*
Outturn of Planter's friend.	grain	894 lb.	514 lb.
	straw	5,698 lb.	3,692 lb.
Outturn of cotton,		377·7 lb.	387·5 lb.

It is scarcely possible that the different systems of sowing can have caused the whole of the great variation in the outturn from the cereal crop. The north side of the field is better drained, and in the southern plot there was a large mango tree which interfered considerably with the growth of the crops near it, especially with cereal. The crop on the two plots was harvested in different manners; that from the northern plot was reaped bodily on 15th January and the ears cut off afterwards in the yard; from the southern plot the ears were first cut off in the field and the straw was reaped on 20th January. These facts, and the possibility of the straw of the two plots having been in different states of dryness when weighed, may to some extent account for the difference of yield.

Regarding the cotton, it will be observed that the outturn of the two plots differs but slightly. The wide interval between each pair of

rows gives facilities for cleaning the ground during the growth of the crop, which the narrower uniform intervals do not afford. The space between the pair of rows is more difficult to weed, but this is of minor importance compared with the advantages gained in being able to till throughout the season nearly two-thirds of the land.

From further experience this new arrangement has now been regularly adopted in sowing cotton, as it is a far cheaper and more convenient system than that of sowing cotton in alternate lines with a cereal.

In 1882, a portion of field No. 11, sown with cotton, which measured 2·96 acres, was divided into two portions of equal area, and one plot was occasionally irrigated. The next statement affords full information regarding the results :—

Plot.	Area.	How often watered.	Quantity of water applied.	Equal to rainfall.	Actual rainfall.	Total amount of water.
	ACRES.		C.FT.	INCH.	INCH.	INCH.
Irrigated ...	1·48	14 times.	36,120	6·72	37·92	44·64
Unirrigated ...	1·48	*Nil.*	*Nil.*	*Nil.*	37·92	37·92

Plot.	Outturn of cotton in seed.		Obtained by ginning.				Percentage of lint in cotton in seed.
			Per plot.		Per acre.		
	Per plot.	Per acre.	Cotton lint.	Seed.	Cotton lint.	Seed.	
			LB.	LB.	LB.	LB.	
Irrigated ...	811·25	548·14	229·05	523·50	154·76	353·71	28·23
Unirrigated.	613·75	414·69	193·25	423·25	130·57	285·09	31·48

In 1876, an investigation was commenced to determine the best linting portion of the season. In 1877, owing to the nature of the season, it had to be suspended, but since then it has been continued regularly. The results are given in the table below, which shows the percentage of lint obtained from the cotton in seed picked and the percentage of the year's crop harvested in each month.

Month Crop harvested in.	1876.		1878.		1879.		1880.		1881.		1882.		1883.		1884.		Average.	
	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops.	Percentage of lint.	Percentage of total crops in each month.
January	33·8	4·71	28·29	7·91	...	...	28·7	4·68	...	...	...	...	...	...	...	...	30·26	2·16
February	35·12	8·02	32·5	·45	32	72·15 (February and March)	31·3	2·71	...	...	...	...	31·38	28·97 (February and March)	32·81	1·53	32·51	7·90
March	36·55	12·47	30·84	26·88	32		31·8	21·80	27·98	7·05	28·56	27·47	31·38		32·13	4·49	31·40	18·83
April	36·14	16·21	31·44	26·65	33·5	11·71	31·5	19·20	27·50	3·89	34·20	22·84	30·69	4·16	31·1	6·90	32	13·94
May	32·35	10·46	31·39	9·71	31·2	3·71	32·4	30·71	29·12	8·30	29·24	13·81	31·72	22·15	29·96	5·70	30·92	13·06
June	28·20	10·46	27·82	25·60	30·2	7·43	30·2	15·12	27·35	20·02	32·07	16·47	28·66	24·32 (June and July)	27·33	8·82	28·97	14·51
July	24·47	13·53	29·73	2·64	30·2	4·70	27·4	2·92	30·70	12·80	30·04	11·61	28·66		24·54	22·13	28·21	10·31
August	23·06	13·32	...	...	...	...	27·4	2·91	29·89	11·10	29·67	7·78	28·45	7·13	25·6	30·73	27·34	9·12
September	30·69	10·81	...	...	...	...	...	...	30·44	5·43	...	...	32·12	14	27·51	19·70	30·19	6·24
October	...	...	...	...	...	...	...	...	30·10	30·44	...	...	...	...	...	...	30·10	3·80
Average of the year	29·99	...	29·58	...	32	...	31·22	...	28·93	...	30·35	...	30·61	...	26·75	...	...	...

It is very seldom convenient to keep cotton on the land in September and October unless in an exceptional season, and from these results it appears that after July it would generally be undesirable to keep cotton on the land; for not only is the outturn shown to be chiefly given in the early months of the year, and the percentage of lint produced after June low, but also, during the showery weather of July and August, it is most difficult to keep down the weeds, and in all probability, if the crop is kept on the land for a longer period in the hope of obtaining rather more yield, the succeeding crop will be endangered, and great expense will be involved in cleaning the land again. It would also appear better to sow the cotton crop at an earlier date than has been customary; instead of September, August should be the month chosen; by this means, cotton-picking might begin at the end of December, instead of the end of January or the beginning of February, which has been until lately the usual season. By this means a longer gathering season during the early months of the year, when the percentage of lint is greater, the staple longer, and the sample usually much cleaner and not stained with oil, would be obtained, and the temptation to keep the crop on the ground late, in hope of obtaining a further gathering, would be lessened.

Egyptian Cotton.—In 1872 a plot was sown with this variety which grew admirably; it seemed quite as well suited to our soils and climate as any variety that had been tried; it has, however, one serious defect —its spreading habit of growth. Instead of growing upright like other varieties of cotton, it spreads over the ground; and, while a plant frequently covers with its branches a space measuring from 4 to 6 square yards, there are few plants 3 feet in height; the result is, that it is exceedingly difficult to clean land that is under this crop—cattle, in working hoes and cultivators between the rows of plants, committing much havoc amongst the lateral branches, and we cannot afford the amount of manual labor required to keep the land clean if bullock labor is not employed. The Egyptian cotton-plant produces large boles, and its fibre is both longer and softer and silky than that of the New Orleans variety; and in the ease with which the cotton can be separated from its seed, the variety possesses one advantage over all others that have yet been tried. It is believed to be descended from Sea Island seed imported originally into Egypt. The variety has been allowed to drop out of notice on the Farm.

Sea Island Cotton (*Gossypium Barbadense*).—In 1878 a supply of seed of this variety was received from America, but very late in the season, and a bed in the experimental grounds was sown with it on the 10th of May. Great difficulty was experienced in raising the plants, for the seed had a very low percentage of vitality, and, although it was sown very thickly, the plants appeared unevenly over the ground, which necessitated several resowings to fill the blanks. To prevent the surface from being crusted over, which is so detrimental to germination and to the first growth of plants, the seed was first covered with about one inch of soil and then with about two inches of horse manure. The beds were also frequently watered to keep the temperature of the soil low, but in spite of these precautions the plants made little progress at first. Showery weather in August and September revived the plants, which after that grew

very vigorously. The plants flowered profusely during October and November, but all the flowers dropped off: the rank growth during August and September probably causing this. The cotton again commenced to flower heavily in December; this time very few of the flowers dropped off. Some cotton was gathered from January 1879 up to March; that gathered in January was the best, the boles being large and the lint very long. Most of the boles produced during February and March were attacked by an insect, which was generally found inside the seeds and thus prevented the seed from maturing and lessened the amount of lint produced. Since then, however, the seed of this variety has been lost and a new importation of it will be required, but it does not appear to flourish on the Farm soils.

Upland Cotton (*Gossypium hirsutum*).—Some seed of this variety also was obtained from America and sown at the same time as the Sea Island. The seed germinated much better than that of the latter variety, and the plants grew slowly but steadily; they also did not produce so much wood and leaf. Flowering commenced later and the flowers were fewer in number than in the case of the Sea Island cotton, but few of the flowers dropped off and the yield was much better. The cotton was all gathered by the middle of March, when apparently all circulation of sap ceased. The plants then were cut down to one foot above the ground and the plot was watered and dug over. At the end of the month the old stools were throwing out fresh shoots. The lint of this cotton is very short, but the variety is very much esteemed in America on account of the heavy outturn it gives; it is said that while Upland cotton yields 400 to 500 lb. of lint per acre, the Sea Island yields only 200 to 250 lb.; so that, although the price of the latter cotton is much higher than that of the former, an acre of Upland cotton is more profitable than one of Sea Island.

Nankin Cotton.—The first mention of this variety in the Farm reports is the following from that for the year 1879:—

"*Nankin Cotton* (*Gossypium Siamese rubra*).—Some seed of this variety of cotton was received from Italy, and sown in the month of January. The seed germinated, but the plants have not thriven well; they are very small and have produced but little up to date. Some of the seed gathered will be again sown, and it is possible that the plants raised from this seed will thrive better than the plants grown from the imported seed. As far as may be judged at present, this cotton does not possess any great agricultural value."

Since the recent adoption of khaki clothing by the army, attention has been drawn to the self-colored cottons, and experiments are being made in their growth. The variety has long been known in the presidency, but is not appreciated as it is a poor yielder. It has been found that the lint produced is generally far from being uniform in color, and that it bleaches very readily under the action of rain or dew and the sun.

Yca Valley Cotton (*Gossypium peruvianum*).—The seed of this variety was introduced by Mr. Clement Markham, when engaged in introducing the cinchona plant into India from Peru. It was obtained from the coast valley of Yca. During Mr. Markham's visit to this country in charge of the cinchona plants, it occurred to him that many districts in the eastern part of the presidency possessed

the same conditions of climate as the coast of Peru, and he therefore suggested that the plant might be introduced with great advantage into this district. The first supply of seed seems to have been received in this country during the latter part of 1864, and was distributed by the Board of Revenue to the Collectors in charge of the districts referred to by Mr. Markham : it is neither known what results marked the attempt to cultivate this species of cotton, nor what became of the seed produced, excepting a few ounces given to the Farm by the Hon. Mr. J. D. Sim, C.S.I., in 1870.

From this small supply, sufficient seed to sow five acres was raised in two years. The plant is a perennial. If left unpruned it will grow to a height of 8 or 10 feet. It can be propagated by cuttings, but not with so good results as from seed. It bears transplanting well in the early stage of its growth, that is, before it is three months old, though it may be transplanted even when full grown, but it does not produce well when planted out so late as this. In 1873 it was remarked of it :—

"The small plantation of this variety of cotton has been unfortunate during the past year, having been two or three times attacked by a borer, which, beginning at the tips of the branches, works down the pith into the hard wood, destroying all as it proceeds. The only effective plan of checking the depredations of this insect was to cut off the affected branches a few inches below the portion injured and to collect and burn them ; still the good result of this was only temporary, for a month or two after each of these prunings, the plants were again in as bad a condition as before ; but by persisting in cutting away injured parts of the plant, I hope eventually to get rid of the pest, though many fine plants will, in the meantime, be sacrificed in spite of every care. The insect appeared in the Yca valley plants in all the plots, though these were at a considerable distance from each other : no other variety of cotton was attacked by it, though in one or two instances the plots of Yca valley plants were quite surrounded by cotton plants of other varieties."

A year later it was again reported :—

"The borer before noticed continues to commit great havoc amongst the plants ; the shrubs have again and again been pruned of all their affected branches, which have been collected and burnt, but in spite of every effort the borer has continued its depredations, and many of the plants are now reduced to little more than bare stumps ; the ground on which they are growing has been thoroughly cultivated and various manural dressings have been applied, but the effect was only to stimulate the growth for a time, the extra luxuriance produced apparently only affording greater scope for the depredations of the borer, and since then the few remaining plants have completely died out. This is to be deplored, for the cotton was a most valuable variety ; for the quality of the cotton was certainly all that could be wished ; indeed, probably a better cotton was never produced in this country."

Samples of the produce were submitted to professional examination, and the following was Dr. Forbes Watson's Report, through whom these valuations were obtained :—

"This cotton was submitted to, and valued at from 10*d.* to 10½*d.* per lb. by, the Cotton Brokers' Association in Liverpool. It was likewise valued by a firm of brokers in the same place, and at the same time, at from 10*d.* to 11*d.* per lb.

"It is considered to be similar to Peruvian cotton, and the prices named are nearly identical with those quoted for the best qualities ('good and fine') of Peruvian cotton at the same date, and it ranks higher than good 'Egyptian,' as will be seen from the subjoined table, which gives the means of comparing the value of the Yca valley sample from Madras with that of similar samples in the Liverpool market during the week ending 28th September last:—

Classification and value per pound.

—	"Ordinary."	"Middling."	"Fair."	"Good Fair."	"Good."	"Fine."
Cotton from Yca Valley seed grown in Madras in 1871, value 10d. to 11d. per pound.						
Peruvian	$6\frac{3}{4}$	8	$9\frac{1}{2}$	$9\frac{3}{4}$	$10\frac{1}{4}$	$10\frac{3}{4}$
Do.	...	$8\frac{7}{8}$	$9\frac{3}{8}$	$9\frac{1}{2}$	$9\frac{3}{4}$	$11\frac{1}{2}$
Egyptian	$7\frac{1}{4}$	$8\frac{1}{4}$	$9\frac{1}{4}$	$9\frac{1}{2}$	$10\frac{1}{4}$	13

"It should be mentioned that, during the same period, American 'middling uplands' was selling at $9\frac{7}{16}$*d.*, and American 'middling fair uplands' at $10\frac{3}{8}$*d.* per lb., while the price of the two best sorts ('good') of Indian cotton in the market at the time, namely, 'Hinginghat' and 'middling ginned Broach' amounted to $8\frac{3}{4}$*d.* and $8\frac{5}{8}$*d.* respectively."

Another independent report was as follows:—

1*st.*—Rather mixed in color, part being very white, clean, and carefully ginned; the remainder dull, rather dead in color, and not so well ginned.

2*nd.*—Partaking of the same character of the inferior portion of the first bale, but the whole of good staple, long and generally strong, but of woolly description and suitable for mixing with wool.

"This cotton resembles a quality received from the Fiji Islands, raised there, we understand, from seed imported from the Brazil. There can be no doubt but this is most excellent cotton, by far the best we have seen from your presidency. It is a good deal mixed both as regards cleanliness and staple, the latter being far from even throughout the sample."

In ginning, this variety yields most favorably, the proportion being as follows; that of two well known Indian varieties is also given for the sake of comparison.

—	Hinginghat.	Bunnie.	Yca Valley.
Clean cotton	25·15	25·54	38·07
Seed, &c.	74·85	74·46	61·93
Total ...	100·00	100·00	100·00

For several years only a few struggling plants were kept alive and it was thought that the variety had been lost, but by special care enough seed was obtained in 1882 to sow nearly an acre, and then the plants were growing luxuriantly, and, so far, have not been attacked by the borer, from which this variety of cotton suffered so severely in former experiments. The lint is apparently quite as long and good as that produced when the seed was first obtained from South America, and is superior to Sea Island or any other variety of cotton that has been tried at Saidápet. This plantation is being extended, but the plants do not lint heavily. The seed is very large and when fresh its surface is very oily, which accounts for the lint being often stained.

The following figures give the number of seeds in a pound of the seed of each of the following varieties of cotton :—

Yca Valley	7,000
Sea Island	9,000
Upland	14,000

Bahmieh Cotton.—Some seed of this variety, which was supposed to be a hybrid between the ordinary cotton plant and the edible okro or ladies-fingers (*Hibiscus esculentus*), was obtained in 1877 from Egypt. The plant was recommended as being more prolific and more upright in growth than the ordinary cotton plant; but in several experiments made on the Farm the crop did not come up to the expectations formed of it from descriptions given; for, from some reason, although the plants came up rather more uprightly than our ordinary cotton (New Orleans), after some time they began to throw out branches near the roots, and occupied fully as much space as the plants of other varieties.

Indigenous Cotton (*Gossypium herbaceum*).—A piece of land measuring about half an acre was sown with Coimbatore cotton, and was manured and treated in the same way as an ordinary crop of New Orleans cotton. The result was very unsatisfactory; gigantic plants heavily covered by leaves were produced, but the yield of cotton was exceedingly small; the result is, however, quite in harmony with general experience of native cotton. With other indigenous varieties the following results may be noticed:—

" *Western.*—A 5-acre field sown with this variety of cotton and maize in alternate lines yielded 1,766 lb. of seed-cotton equal to 353 lb. per acre, and this was in addition to a fair crop of grain and straw from the maize plants that grew in alternate lines with the cotton plants."

" *Hinginghat and Bunnie.*—These varieties are grown largely in Bombay, where they are said to be highly appreciated; the results obtained with them differed but little from those yielded by ordinary 'Western' seed."

Experiments have been made on more than one occasion in treating cotton as a biennial instead of an annual crop; but it has not generally been found to answer, for not only is the yield in the second year deficient, but the land also, when kept under cotton for so long a period as two years unintermittedly, becomes excessively foul, and this necessitates a heavy expenditure on cleaning it afterwards.

Cotton seed is well known to contain a useful and valuable oil, and in the United States of America experiments in extracting it were

made as long ago as 1826, but not till 30 years later—when experiments were made in first decorticating the seed and pressing the kernels only—were satisfactory results obtained. The industry now affords employment to very extensive factories. The products are a fine oil, used when refined as a substitute for olive oil and in the crude state by soap-makers, and "cotton seed cake," which is classed amongst cattle feeders with linseed cake and is especially valuable for milch cows.

An experiment was made on the Farm in pressing some New Orleans cotton seed. It was first crushed in a mill and sifted to remove the husk, and 100 lb. of seed yielded 34 lb. of kernels. The kernels—decorticated seed—were then pressed in an ordinary oil mill and 100 lb. of them yielded 16 lb. 15 oz. of oil and 71 lb. of cake. With an hydraulic press more oil could easily be extracted. In the United States 1 ton of cotton seed is said to produce 35 gals. of oil and 750 lb. of oil cake; in the experiment recorded, the outturn was only at the rate of 10 gals. of oil and 795 lb. of cake per ton of seed, and it is thus evident that in crushing the seed a good deal of the kernels was removed with the husks. The industry is worthy of the attention of capitalists, but it is evident that proper machinery must be provided to carry it out.

ROSELLE.—In 1875 a small plot of land was sown with this crop: the soil was a free sandy loam: after the land had been well manured, the seed was sown on 1st February at the rate of 24 lb. per acre on the ridge. During the growth of the crop the land was once hand-hoed, once bullock-hoed, and irrigated eighteen times. The seed germinated well and the plants grew with great vigor; they were straight and almost without side branches, and averaged between 5 and 6 feet in height when ready for cutting about three months after sowing. As the crop was grown chiefly in view to the production of seed, the fibre of the plants was not utilized; a few plants were, however, cut down when in flower in order to ascertain the quality of their fibre; the result was very satisfactory, for the fibre proved to be long in staple, strong, and silky. Similar experiments have since then been frequently made, but owing to the difficulties and expense of manufacturing the fibre, the plant has not been adopted as a field crop.

SUNN HEMP—has also been frequently grown experimentally. In 1875 a plot was sown on 2nd February with seed at the rate of 50 lb. per acre on ridges two feet apart; during the growth of the crop it was watered eight times. The seed germinated well and the plants grew with great luxuriance, but when they had reached the time for cutting, there was no fibre whatever in their stems. The soil of this plot is a sandy loam, and probably the high cultivation and watering were unfavorable to the production of fibre. In 1877 another experiment was made: for it a piece of land measuring 585 square yards was selected; it is a light and very sandy loam, then recently levelled with a slope of about 9 inches in 300 feet. The land was prepared for an ordinary crop by ploughing and harrowing until it was reduced to a proper state, and the seed was then sown with the drill in rows 9 inches apart at the rate of 12 lb. per acre. The land had been manured with horse-manure at the rate of 12 loads, or about 4 tons per acre. The after cultivation consisted of two hand hoeings. The following

table gives the outturn obtained; the plot was divided into three equal portions, and each of these again, excepting the last, was subdivided into two; the whole of each main division was harvested on the same day, one-half being pulled and the other reaped close to the ground; the land, however, became so hard before the last plot was reaped that none of it could be pulled up with the roots. The results were as follow:—

Date of harvest ...	4th December.		15th December.		24th Dec.
Area of land ...	877·5 sqr. ft.	877·5 sqr. ft.	877·5 sqr. ft.	877·5 sqr. ft.	1,755 sqr. ft.
Condition of plant when cut.	Flowering.		Seed pods formed and partly matured.		Seed ripened.
Method of harvest ...	Cut level with ground	Pulled up by the roots.	Cut level with ground	Pulled up by the roots.	Cut level with ground.
Duration of steeping and temperature of water.	6 days; 78°.		4 days; 82°.		4 days; 82°.
Yield of fibre ...	6 lb.	6·5 lb.	8·5 lb.	9·75 lb.	17·5 lb.
Yield of fibre per acre	298 lb.	$322\frac{1}{2}$ lb.	422 lb.	484 lb.	434 lb.

After being removed from the ground, the stems were tied in bundles of about 50—100 each and placed to steep in a tank, being weighted down to keep them under water; when considered fit, the fibre was removed from the wood by splitting it off by the hand; it was then washed and dried; it came off in a very matted and tangled condition and there was not much difference in the quality or color of the different cuttings, all the samples being coarse, lightish yellow in color, and of nearly similar strength excepting that the last was rather stronger than any of the others.

The plant grows freely on the soils of the Farm, if generously treated.

JUTE.—In 1874 a considerable area of land was cropped with one variety of this plant (*Corchorus olitorius*). The experiments were made at different seasons from June up to the end of the year; in some the seed was first sown in seed-beds, and the young seedlings afterwards transplanted into the field; in others it was sown directly in the field; in some experiments it was sown thinly on drills placed wide apart, in others on the flat in lines with but small spaces between. Some of the experimental plots were regularly watered during the growth of the crop, while others depended on the rainfall only. The soil of nearly all the plots was a sandy loam. In all the experiments the seed germinated well, and the plants looked strong and healthy, but in nearly every instance they flowered when only about six inches high and threw out an immense number of lateral branches, these rendering the plant of but little value for fibre-producing purposes.

In 1877 an experiment was made with the other variety (*Corchorus capsularis*) on some light sandy soil which had been fairly manured; the crop was sown on 5th September and when it appeared fit for harvest the following experiment was made :—

Date of harvest	29th November 1877.	
Area of plot treated	420 square feet.	
Condition of plant when cut	Seed partially matured.	
Method of harvest	Reaped close to the ground.	Pulled up by the roots.
Duration of steeping	11 days.	
Temperature of the water	82°.	
Yield per plot	5·75 lb. fibre.	6·75 lb. fibre.
Yield per acre	596 lb. fibre.	700 lb. fibre.

The fibre produced was very similar in both cases, but the increased yield of 100 lb. per acre when pulled, shows that that method of harvesting seems to be the best; the weight alone however cannot be taken as a conclusive proof, for the ends of the pulled stem fibre were more woody than the other. The fibre was cleaned in the same way as the Sunn already referred to, and came out in a fine glossy silky state, averaging from two to three feet in length, and being of great strength. In a better season and on a less sandy soil heavier returns and a better sample might have been obtained; in this case, the crop suffered considerably from a drought in October and probably did not attain such a fine growth as it might have done.

The crop has since been grown frequently on small areas, but, though it grows fairly when carefully cultivated, it does not seem adapted for general growth on such light soils as those of the Farm in this climate.

Rheea or China-grass.—In November 1875, 100 roots of this plant were received from the Superintendent of the Botanical Gardens, Saharanpore, North-West Provinces. The roots were much out of condition on reaching Saidápet, from the length of time (a week) occupied in transit. They were planted out at once, and a considerable number of them grew and produced healthy plants, but during the succeeding hot season the leaves of most of the plants became so bleached and discolored, apparently from the high temperature prevailing at the time, that it was deemed necessary to remove them to a plot of ground somewhat shaded from the sun. The change was beneficial, and the leaves assumed a healthy green color.

Further experience shows that the crop will grow very well during the cold weather, but does not produce very long stems; they are,

however, generally straight and branchless, and contain a large quantity of very strong fibre. Undoubtedly the plant may become a very valuable crop in many parts of the presidency if some economical means be devised for extracting the fibre. It will produce heavily, for on one occasion, from a small plot of about 4 square yards, in one cutting $\frac{1}{4}$ lb. of fibre was obtained, and from the nature of the plant not less than four and perhaps more cuttings could be obtained per annum; but to do this abundant manure and some irrigation would be required. The cost of growing the stems need not be heavy, but until some machine capable of cleaning the fibre cheaply is produced, it is not of much use endeavoring to introduce the plant here where we have many other more easily manipulated, though not so valuable fibres.

Malachra rotundifolia.—Some seed of this fibre plant was obtained in 1879 from Bombay, where it is said to grow wild. It, however, has not been found to grow freely on the Farm.

Hemp (*Cannabis sativa*)—grows fairly during the cold season on carefully-prepared soil, growing to a height of 5 or 6 feet, but does not seem adapted for growth as a field crop on the Farm soils.

Flax (*Linum usitatissimum*).—In 1870 a few pounds of Egyptian flax were sown on the 26th November. It grew very satisfactorily. It was cultivated as a dry crop and matured its seed. The crop was not more than two and a-half feet in height; but the weather was unusually dry during its growth.

In 1876 a crop, giving similar results, was grown from Australian seed; it was sown in November and occasionally watered; it grew well, and was very healthy, but did not attain great height (only about 21 inches), as it was sown at wide intervals for the sake of seed.

In 1882, regarding some further experiments with crop grown from indigenous seed, it was observed :—

"The plants grew fairly well, but they were very short and bushy, even though the seed had been sown very thickly. It is the usual practice in this country to sow linseed for the seed rather than for fibre; hence it is customary to sow thinly. This secures a better crop of seed, though it spoils all chance of any good fibre being produced. Probably, if the indigenous seed was sown successively for several seasons, specially in view to producing tall branchless plants, this result might be obtained. The small plot gave an outturn of seed at the rate of 302 lb. per acre."

Manilla Hemp.—More than one attempt has been made to introduce this plant, the first being with some shoots obtained in 1877 from Calcutta, all of which, however, seemed unable to exist in the climate of Saidápet and died off within twelve months. In 1879, however, a more successful experiment was commenced, a number of shoots having been obtained from the Wynad, and planted out with care, but in the same manner as ordinary plantains. Regarding these plants it was observed in 1882 :

"The plot of Manilla hemp plants has been considerably enlarged during the year by planting out the shoots of the matured plants. The plants have grown well under the same conditions as the ordinary plantain. They will not thrive unless planted on a deep well-manured soil and under regular irrigation. Hence, the cost of growing plants until they reach the stage fit for cutting is great; at Saidápet this cost will amount to not less than 2

annas each. It costs about the same sum to bring into bearing a plant of the ordinary variety of plantain, but then, the bunch of fruit may be worth 4 or 5 annas at the least, whereas the fruit of the *Musa textilis* is of no value."

During the previous year some experiments had been made, the results of which are shown below. In the first experiment three stems were treated on 12th November 1880 with the following results :—

Number of plant.	Dimensions of stem.			Yield of fibre.	
	Weight.	Length.	Circumference near the ground.	From one plant.	Per cent. of stem.
	LB.	FEET.	FEET.	LB. OZ.	
1	138	11	2½	1 2	·81
2	56	6	1¾	0 6	·67
3	72	9	2	0 10	·86

Another experiment was made in March 1882 with the following results :—

Number of experiment.	Stem.									Yield of fibre.			
	Length.	Circumference.			Weight of					From inner portion.	From middle portion.	From outer portion.	Per cent. of stem.
		At bottom.	At half height.	At top.	Whole.	Inner portion.	Middle portion.	Outer portion.	Pith.				
	FT.	IN.	IN.	IN.	LB.	LB.	LB.	LB.	LB.	OZ.	OZ.	OZ.	
1	8	27	22	18	58	23	...	25	10	4	...	1	·53
2	8¼	30	23	18	78	42	...	31	5	5	...	1	·48
3	8	30	23	18	77	22	23	27	5	4	1¼	1	·50

Some of the plants were in flower, and some bearing fruit, when they were cut. It was, of course, undesirable, as regards the production of fibre, that the plants should be allowed to stand so long as to produce fruit, but the intention had been to try to rear plants from the seeds, which was frustrated by a cyclone prostrating the plants; they were therefore utilized as already shown. The men when engaged in separating the fibre were allowed to work in their own way in the manner adopted in extracting the fibre of the common plantain. The process is extremely clumsy, very slow, and very costly. With practice the men might have done better, but they never would be able, by their process, to produce prepared fibre at a cost sufficiently low to admit of it being sold at a profit.

Another experiment was made in June 1882, the results of which are shown in the following table, some experiments in extracting the fibre of the common plantain being made at the same time.

Date.	Number of stem.	Stem. Length.	Stem. Circumference.	Stem. Weight of The whole.	Stem. Weight of Pith.	Stem. Weight of Portion used.	Layer used.	Weight of fibre obtained.	Time occupied in operations. For crushing.	Time occupied in operations. For steeping.	Time occupied in operations. For washing.	Time occupied in operations. For beating.	Cost of operations.	Cost of preparing the fibre per pound.	Remarks.
Manilla Hemp.		FT. IN.	IN.	LB.	LB.	LB.		OZ.	MINS.	HOURS.	MINS.	MINS.	A. P.	A. P.	
17th	1	6 9	19	34	9	25	Outer ...	4⅛	13	...	10	45	1 0	3 10	Crushed, washed and beaten at once.
							Inner ...	3½	9	...	10	40	0 6	2 3½	
17th	2	6 10	20	35	8½	26½	Outer ...	3	12	3	...	55	1 6	8 0	Steeped for three hours and then crushed.
							Inner ...	3½	11	3	...	52	1 0	4 3½	
20th	1	6 2	25	55	6½	48½	Outer ...	7	18	...	10	40	0 6	1 1½	With flower stalk, crushed and beaten.
							Inner ...	13½	12	...	8	30	0 4	0 4¾	
20th	2	8 0	34	128	17¾	110¼	Outer ...	16½	35	3	15	60	0 11	0 10⅔	Without flower, crushed, steeped 3 hours and beaten.
							Inner ...	16⅓	25	3	12	48	0 8½	0 8¼	
20th	3	9 0	29	105	16	89	Outer ...	12¼	28	...	15	55	0 10½	1 1⅓	Without flower, crushed and beaten.
							Inner ...	16¼	18	...	11	48	0 8	0 7½	
Common Plantain.															
16th	1	5 0	21	32	7½	24½	Outer ...	3	10	3	15	50	1 0	5 4	Steeped and then beaten.
							Inner ...	3⅝	...	3	12	40	0 8	2 11	
16th	2	5 2	19	30	4¼	25¾	Outer ...	7¼	12	3	10	...	0 9	1 7	Steeped for three hours and then crushed.
							Inner ...	8¼	...	3	8	...	0 6	0 11	
16th	3	5 0	15	20	3	17	Outer ...	3¼	11	1	...	...	1 6	7 4	Boiled for one hour after crushing.
							Inner ...	3½	...	½	...	...	1 0	4 9	Boiled for half an hour after crushing.

A roughly-made stem-crusher was used in the experiments; it consisted of a pair of wooden rollers about a foot long and four inches in diameter, fixed in uprights, and worked by a handle. Two men were needed to work the machine, and two to feed and remove the fibre, &c. A mill on the principle of the Beheea sugar-mill, with wooden instead of iron rollers, would, it is believed, do good work. The machine used in these experiments had neither cogs for driving nor means of adjustment. With the aid of proper apparatus a roughly-prepared fibre for rope-making might be turned out at a sufficiently low cost. The ordinary selling price of Manilla hemp rope in Madras is 5 annas per pound.

In the next table the results of some experiments made in March 1884 are given. The cost of preparing the fibre according to the manner of the first experiment may be estimated at one anna a pound, but it was only fit for cordage. A cheap machine for crushing is required if the plant is to become generally valuable.

Number of experiment.	Stem.				Layers fit for fibre making.				Weight of the layers after scraping.		Yield of clean fibre.		Remarks.
			Girth at		Outer.		Inner.						
	Weight.	Length.	Base.	Top.	Number.	Weight.	Number.	Weight.	Outer.	Inner.	Outer.	Inner.	
	LB.	FT. IN.	IN.	IN.		LB.		LB.	LB.	LB.	OZ.	OZ.	
1	88·5	...	28	16½	8	24	14	49	9	19	9	4	Roughly scraped; buried in sand for 11 days and washed by beating on a stone; fibre dark colored.
2	97·5	6 7	30	20	11	42·8	13	42	16	13	12	5	Roughly scraped; steeped in water for 9 days and washed as above; fibre white and pure.

The plant is chiefly valued for its fibre and cut before the fruit forms; however, the ripe fruit would not be unpleasant eating were it not for the excessive number and size of the seeds it contains. The following statement will give a fair idea on this point :—

Fruit.		Weight of				Number of seeds in a fruit.
Length.	Girth.	Fruit.	Peelings.	Seed.	Pulp dry.	
INCH.	INCH.	LB.	OZ.	OZ.	OZ.	
6½	4½	1·90	4	¾	11½	139

As may be imagined from these figures, it is a troublesome matter to eat the fruits, though they are sweet and of a pleasant flavor.

Though the fruit is not acceptable to the higher classes, it is valuable even if used only for feeding cattle. Bunches have been found to average 120 lb., each fruit weighing about 4 oz. The unripe fruit when made into curry has a remarkably astringent character.

An experiment was made in extracting starch from some fruits of this plant which were not fully ripe, when the following figures were obtained :—

Fruits taken—	Weight of—
Number, 38.	Peelings, 8 lb. or 44·5 per cent. of fruit.
Weight, 18 lb.	Pulp, 6 lb. or 33·3 do.
Average girth, 5 inches.	Seeds, 4 lb. or 22·2 do.

The large proportion of seeds is partly due to the fruits having been unripe and the pulp consequently adhering to the seeds. The yield of starch was ½ lb., or 2·71 per cent. of the fruits and 8·3 per cent. of the pulp. It was greyish white in color, soft to the touch, did not become viscid when mixed with water, and tasted like rice flour. The process adopted was to peel the fruits with a wooden knife, squeeze the pulp in water, and extract the seeds. The pulp was then dried in the sun for a day and powdered with a wooden pestle, and the powder sifted through a piece of cloth.

The plant has become thoroughly acclimatized at Saidápet and now grows with little care or attention and requires very little watering. A considerable number of shoots have been distributed in various parts of the presidency, and when the machine referred to above has been found, it may become a valuable addition to our field crops. It is, however, probable that attention should rather be given to the common plantain, as the fruit of that plant repays the cost of raising it and leaves the fibre all for clear profit.

Plantains.—Since 1872 there has always been a patch of greater or less extent under this crop near one of the wells. Besides being a valuable and remunerative crop, it affords labor for the coolies during the dry weather. It requires careful tillage and heavy manuring to be brought to successful maturity, whilst it produces a large amount of palatable food, as well as a fibre held in considerable esteem. The following account of a tope planted in September 1876 is interesting :—

" The plot measured 1·68 acre and was planted with sets placed in rows 6 feet apart either way. The cost of maintaining the plantation until the 1st of June 1878 was as follows :—

Year.	——	Total. RS.	A.	P.	Per acre. RS.	A.	P.
1876	Planting	29	0	0	17	4	2
	Manure and manuring	39	12	0	23	10	6
	Hoeing and digging	17	6	0	10	4	3
	Watering	1	8	0	0	14	3
1877	Hoeing and digging	34	14	0	20	12	2
	Watering	60	12	0	36	2	7
	Manure and manuring	54	0	0	32	2	3
1878	Digging and hoeing	7	8	8	4	7	10
	Watering	45	0	0	26	12	7
	Total ...	289	12	8	172	6	7

" This expenditure may be classified per acre as follows :—

—	Cost.	Per cent. of total.
	RS. A. P.	
Planting	17 4 2	10·01
Manure and manuring ...	55 12 9	32·36
Watering	63 13 5	37·03
Digging and hoeing	35 9 5	20·60
Total ...	172 7 9	100·00

" The land on which the tope is situated is of very poor and varying quality, the greater portion being a coarse sand, and the remainder a sour stiffish loam, on which nothing has flourished, and on which the plantains even are comparatively stunted. The manure used was, for the first application in 1876, partly blood compost and partly poudrette, that for the dressing given in 1877—in September—chiefly blood compost, but box-manure was also used for a few trees. Up to the end of 1877 the fruit yielded was of inferior quality, but since then, now that the last dressing of manure has acted, they have a flavor than which I have never noticed a better.

" Against the cost of production must be set the receipts up to the 1st of June for 332 bunches, which sold for Rs. 78-6-9, or Rs. 46-10-10 per acre ; at the same date the trees standing on the ground were valued at Rs. 312-8-0, or Rs. 186-0-2 per acre, leaving a balance of Rs. 101-2-1, or Rs. 60-3-2 per acre in favor of the plantation after one year and nine months' existence. From February 1878 the weight of the bunches received was recorded, and although it was not large, 176 bunches weighing 2,289 lb. ; yet assuming the whole number received to have been about the same weight, the yield per acre in the months during which the plantation was bearing amounted to between 2,500 and 2,600 lb. per acre. It was found by experiment that the yield of food (pulp) from the bunches was about 49 per cent. of their weight, so that the rate per acre was about 1,250 lb."

Miscellaneous and Garden Crops.—The *Egg plant* or *Brinjal* (*Solanum melongena*) is frequently grown on a small scale as a hot-weather crop under occasional irrigation. The crop is a profitable one, especially for the small farmer who does not employ laborers. The fruit is yielded gradually during four or five months. Three or four thousand pounds of fruit are frequently obtained per acre on the Farm, and as much as 5,600 lb. have been obtained. The plants are usually raised in seed beds and dibbled in on both sides of ridges made two feet apart, and require irrigating about once a week.

The *Potato* (*Solanum tuberosum*)—has been tried with seed derived from various sources, but though it frequently produces vigorous plants the tubers do not form.

The *Sweet potato* (*Batatas edulis*)—is sometimes raised and produces fair crops. The tops of this plant have been used green as cattle food and the cattle seemed to like them. The plant will produce about 6,000 lb. of tops per acre.

Tapioca (*Jatropha manihot*).—In 1871 a piece of land measuring 1,200 square yards was planted with cuttings of this plant obtained from Travancore. The land planted was a piece of poor sandy soil on the western side of the Farm. A stiffer soil could have been

provided had this been thought necessary, but small experiments made in previous years on heavier soil seemed to indicate that it was not the most suitable, while it is a well known fact that starch is developed more freely in tubers and fleshy roots when the soil in which they are growing is free and thoroughly aërated than when it is stiff and compact, and the commercial product of tapioca chiefly consists of starch. The soil was naturally a very poor one, and contained fully 90 per cent. of sand, but its poverty was, to some extent, compensated by giving it a heavy dressing of fold-yard manure. The land was first thoroughly ploughed, grubbed, and weeded. It was then ridged about 30 inches apart, and the manure spread in the open furrows between the ridges. The plough was then passed along through the centre of the ridges, throwing the soil over the manure on each side, thus raising a new ridge immediately over the manure. The cuttings were planted on the 17th of July on the ridges, in pairs crossing each other obliquely, each pair being planted about three feet apart; the ground being exceedingly dry at the time, the cuttings were twice watered (with chatties). They were afterwards left entirely to the weather, and received no other attention, except a slight weeding. The plants grew well and vigorously, but were too heavily covered with leaves for such a light soil as that in which they are growing, as, during the cyclone which broke over the district in the early part of May 1872, the whole crop was prostrated, and nearly the whole of the plants being permanently injured, no alternative remained but to gather the crop. The tubers weighed 656 pounds; but, as they were not matured, they possessed no commercial value.

The sandy soil seems suitable, but evidently too much fold-yard manure was used (box manure is rich in nitrogenous or leaf-producing matters); had less of it been used, and with it a small quantity of some phosphatic manure (bone dust, or animal charcoal), a good result would probably have been more certain.

On several more recent occasions the crop has again been grown; thus in 1878 it was remarked:—

"On the 21st of August a bed was planted with cuttings of this crop. The cuttings were placed half yard distant in the lines and the lines were 1 yard apart. The cuttings struck root easily and attained a height of 6-7 feet. The plants were cut down and the tubers taken up on the 4th March 1879. The yield of tubers was at the rate of 10,880 lb. per acre. This outturn is certainly very satisfactory. The plants are most easily propagated and require little attention during their growth. As the branches and leaves soon cover the ground, little irrigation is necessary."

And again in 1881—

"A small plot was grown in the botanical grounds; the plants were in rows about half a yard apart; the ground was occasionally watered. The outturn of tubers was 6,487 lb. per acre. No attempt was made to extract the starch."

The tubers meet with a ready sale locally as a vegetable.

Arrowroot (*Curcuma angustifolia*)—was first grown on the Farm in 1878, when a bed was planted with the crop on the 19th August; it grew fairly, but required more water than tapioca; the tubers were taken up on the 1st of March 1879; the yield was found to be at the rate of 3,764 lb. per acre.

Again in 1881 regarding this crop it was remarked :—

"A plot measuring ·25 acre was planted with this crop at the end of 1879, and remained down during the year under report. It was taken up at the end of January last and yielded 986 lb. of tubers, or at the rate of 3,944 lb. per acre. The yield of flour obtained has generally been about 12½ lb. from 100 lb. of tubers, so that the above yield would represent an outturn of 493 lb. of flour per acre. In another case in the College Experimental Garden, a plot measuring 1,160 square yards planted with this crop yielded 1,798 lb., or at the rate of 7,500 lb. per acre. The culture of this crop is very simple: it is only necessary to plant the sets in properly-prepared soil, and to water them occasionally during the dry season. The removal of the crop is tedious unless the tubers can be ploughed out, as potatoes are done in England, which is seldom possible owing to the dryness of the soil, so that the tubers have to be dug up. The preparation of the flour is also very simple and easy. The tubers have only to be reduced to pulp on a grater after being well washed to remove soil and dirt, and then the pulp is mixed thoroughly with water so as to separate the starch completely from the fibrous matters. The whole is afterwards strained through cloth, through which the starch and water passes, and the fibre left behind. After this the starch has only to be thoroughly washed by decantation with clean water, and dried in the sun. It is then rolled on a table to break it up thoroughly into fine flour and is ready for sale. The flour can be produced at a very low price; it could be sold profitably at 4 annas per pound."

Artichokes (*Helianthus tuberosus*).—A plot of land measuring about one-fifth of an acre was ploughed and manured with four cartloads of fold-yard manure, and, on the 23rd of August 1870, planted with 35 lb. of artichokes. The sets were planted about a foot apart in lines. The crop was harvested on the 8th of February following and yielded 331 lb. of tubers or 1,655 lb. per acre. The tubers were used as food for pigs.

In the earliest days of the Farm both Beet-root and Mangel-wurzel (*Beta vulgaris*) were tried on a small scale, but it was soon seen that, although fair crops could be grown with care, the same care if given to indigenous crops would produce far better results.

Chillies (*Capsicum annuum*)—have also been grown and are usually raised in the same manner as brinjals. The following record of a crop raised in 1882 is illustrative :—

"The crop was a very fine one, the fruits were much larger than are usually seen, although only ordinary seed was used. About two months after planting flowers appeared, and the production of fruit continued until the crop was taken up. Numerous plants had as many as forty fruits at one time, besides being profusely covered with flower. The produce was at the rate of 2,163 lb. of chillies per acre. As the field had to be sown with cotton and maize in September, the chilly crop was taken up when still bearing heavily. There is not much difficulty in producing chillies, if the crop is well watered during its early growth and is kept free of weeds. The fruit can be readily sold either fresh or dry. The condition of the soil, and the kind of manure used, influences greatly the value of the crop. A somewhat stiff soil, and strong manure such as blood-compost, especially suit the crop."

The following remarks were made regarding some other minor crops raised in 1882 :—

"*Chicory* (*Chichorium intybus*).—A supply of seed was obtained from Sydney; it was sown on the 26th December 1881; the crop grew luxuriantly;

the plants were in flower at the close of the year. The roots are fibrous and poor.

"*Tomatoes* (*Solanum lycopersicum*).—This crop did very well indeed; it was sown on the 2nd February 1882, and during the next three months it yielded 683 fruits, varying in size from that of a gooseberry to that of a fair sized guava. It is surprising that this crop, which grows so readily and produces so well, at a season of the year when vegetables and fruits are scarce, should be so little cultivated around Madras. In the warmer parts of America the tomato is very largely grown, and is used not only as a vegetable, but for making jams, pickles, &c.

"*Onions* (*Allium cepa*).—A small experiment was made in growing onions with seed obtained from Cuddapah. The crop matured in about two months from the time of sowing, and gave an outturn of 1,575 lb. per acre —a fair return, considering the season at which the crop was grown, the poverty of the soil, and the short period of growth."

Again in the year following another two crops were thus referred to:—

"*Colocasia antiquorum*.—The so-called country potato known in Tamil as shama-kilanghoo yielded on a plot of 80 square yards 52 lb. of tubers, which was at the rate of 3,146 lb. per acre. Both tubers and leaves are used as human food.

"*Typhonium Orixense*.—The Telinga potato yielded on a plot of 80 square yards 53 lb. of tubers, equal to 3,206 lb. per acre. The tubers are used as vegetables and also for medicinal purposes."

Egyptian Clover and Beans, Rape, Vetches, Lentils (*Ervum lens*), *Lupins* (*Lupinus albus*), and several other useful European crops have been experimented with and the results have generally been such as follows:—

"*Vetches* (*Vicia sativa*) *and Rape* (*Brassica napus*)—Australian seed—were sown, but, although the seed germinated well, neither crop succeeded. The vetches were apparently unable to withstand the heat, and the rape was attacked by caterpillars."

Buck-wheat (*Polygonum fagopyrum*)—has been tried on two occasions. In 1870 a bushel of seed was obtained from Sydney, and a portion of it was sown on the 8th of October on a piece of suitable soil in fair condition. The crop grew and flowered, but did not succeed. In 1876 a plot of 1,300 square yards was sown with this crop, the seed having been obtained from Australia. It grew well and would in an ordinary season have doubtless attained maturity without being watered, but in this case it was necessary to do so. The seed was sown on 9th November, and within ten weeks the crop was off the ground, leaving it ready for another. The yield was at the rate of grain 167 lb., straw 1,136 lb., per acre; but, under more favorable circumstances, it would, there is every reason to believe, yield better results. The crop is useful as a preparation for a cereal or as a green manure. The fodder is good food for cows, and the grain yields, after the husk has been removed, a meal rich in nutritive matters. As an alternative crop with the cereals, as a catch crop after an early one grown for fodder, or grown as manure, buck-wheat can be recommended for some portions of the presidency.

CHAPTER VI.

LIVE STOCK.

THE small size of the Farm, the poverty of its soils, and its situation, together with the presence of the Commissariat slaughter-houses in its centre, have all prevented much being done towards the improvement of live stock. The latter has been a frequent cause of the introduction of disease amongst the Farm stock, and has thus rendered it unadvisable to bring valuable animals to the Farm.

As milk in various forms is the chief and most important animal food of the people of this country, and as the operations of tillage are performed with the aid of oxen only, the necessity for improving the milch and draught cattle of the country is undeniable. Native cultivators object to incur any expense, when grass is scarce, for providing special food for their milch cattle. They argue that bullocks pay for their food in the work they perform, but that the cow yields milk in such small quantities and for so short a period that she will not repay the cost of any special feeding.

Sheep, again, are extensively raised as a source of animal food, but as yet there is no general demand in the country for the supply of well-fed mutton. There appears to be no reason why over extensive tracts Southern India should not compete in the supply of fine wools for manufacturing purposes.

CATTLE IMPROVEMENT.—In attempting to improve breeds of cattle, great care should be exercised in order that the increase in size bears some relation to the supply of food available; in most parts of this presidency, during the dry months, even in a moderately good season, the food available is scarcely sufficient to preserve the lives of the undersized cattle kept by ryots, and would, therefore, be totally inadequate to do even this much for animals of a larger size. Before taking steps to increase the size of the cattle in the more backward parts of the presidency, it is necessary that something should be done to induce ryots to grow fodder, &c., as food for their live stock; for as long as so many ryots consider that it is more economical to allow their cattle to starve or even to die in the dry season rather than to go to the trouble of growing fodder for their use, it will be exceedingly unwise to attempt to increase the size of the cattle they keep.

Native cattle, like native laborers, can adapt themselves readily to the bad conditions with which they have so frequently to contend; they can be starved down to, and be kept alive for a time on a daily allowance of food that represents only a tithe of the quantity they should consume when in full health. This is the ordinary process to which they are subjected every hot season at the hand of their owners. But while it is possible to reduce gradually the daily food of a bullock until in amount it is not one-tenth of the allowance that should be

given, it is not so easy without injury again to increase that allowance to the quantity necessary to support the animal in health; hence the enormous losses that are experienced in this country amongst live stock when, after a long drought, a sudden fall of rain produces a luxuriant and plentiful growth of grass. Few cattle die directly from starvation; the deaths in most cases are the result of the sudden supply of succulent food in abundance, greedily eaten by animals whose constitutions have been weakened by a long and gradual starving process.

From some statistics collected in 1877, it was shown that average native cattle stand higher at the loins than behind the hump; this may be an advantage for draught purposes, by enabling them to throw more weight against the yoke. The length of leg in proportion to the depth of barrel is an excessive and general defect in the cattle of the country, forming over 40 per cent. of the total height of the animals. Their girth is excessively low, not being more in full grown specimens than that attained by cattle of English breeds in less than twelve months.

Sires.—Although a good deal may be done by Government by introducing and breeding good bulls and locating them in selected localities under competent care, much good cannot be done until the practice of using any ill-formed brute as a sire is put a stop to. It would be well that all bulls, unless their owners can procure a license from an officer appointed for the purpose, should be castrated; all licensed animals being branded, numbered and registered.

The live weight of the cows kept by the ryots in the neighbourhood of the Farm generally varies from about 200—400 lb., so that it is a great mistake to expect to obtain a good cross between them and the large Nellore breed, which produces bulls weighing 800 lb. and upwards. It has been urged that it would be best in endeavoring to improve the milch cattle that bulls of the best dairy breeds of Europe should be imported by Government; those of Southern Europe direct, and those of Northern Europe from Australia. Experience has shown that the supposed weakness of constitution in cattle, the produce of a cross between a European bull and a country-bred cow, is groundless, the offspring being perfectly capable of remaining out of doors all day. They, however, generally seek the shade of trees, such as usually exist in good pasture land, during the time when the sun is hottest.

But though this may undoubtedly be true, what is required for the improvement of the cattle in this district is medium-sized bulls of some breed known to be suited for the dairy. With this view, in 1874, one bull, one cow, and two bull calves of the Aden breed were imported, that breed having a high reputation as dairy animals. The name Aden by which they are distinguished probably originated from Aden being the port from which cattle of this breed are generally shipped, as they are not found in the neighbourhood of Aden, but are brought from districts situated at considerable distances from the coast. The animals imported were not nearly so well formed as it was expected they would be, although there is every reason to believe them to be average specimens; probably, with regard to their form and general quality, the breed has been much overpraised.

The cow, however, as will be seen by the records given further on, proved a remarkably good milker, and thus her defects in form may be overlooked, for it must be remembered that there are many highly-valued breeds of dairy cattle in Europe, the cows of which are exceedingly irregular in form. It is also worth mentioning that, in the measurements referred to above, the imported Aden bull showed a better girth measurement than any of the native cattle measured.

It being believed, from the results of the above experiment, that from the use of bulls of this breed on the stock of the ryots a cross would be produced of greater milk-producing capabilities, in 1881 a further importation of 2 bulls, 3 cows and 4 bull calves was made, and again quite recently 15 young bulls, 6 cows, and 6 bull calves arrived, so that the stock of this breed on the Farm stood on the 1st January 1885 as follows:—

—	Bulls fit for breeding.	Young bulls.	Cows.	Heifers.	Calves.
Imported	8	14	9	...	...
Bred in India ...	1	2	2	3	8

and besides these, five bulls and a cow of the breed have been sent out into the districts for breeding purposes.

Housing.—The general neglect of providing proper housing for cattle is another point which must be reformed before much progress can be made in improving them. For although it is only at exceptional times that the special value is particularly shown, the general usefulness of adequate housing is undoubtedly to be found in the general condition and health of all stock so treated; for instance, in Saidápet Taluk, in May 1877, 11,687 cattle and 7,218 sheep died from the effects of exposure in a cyclone; these may be taken to have been of an aggregate value of nearly 2 lakhs of rupees (£20,000). In the Revenue Settlement Report of the taluk submitted by Mr. Banbury in April 1874, it is stated that the number of ploughing and milch cattle in it amounted to 28,316, and the number of sheep and goats to 16,929; the loss therefore amounted to 41 per cent. of the former and 43 per cent. of the latter; no doubt the terribly reduced condition of the stock at the time caused them to succumb in such numbers, but had they been protected from the rain and chill consequent on their exposure, the loss would have been trifling. On the Farm, in a stock of 31 cattle not one was lost, whilst out of 300 sheep three or four died, possibly from the effects of the weather.

Working Cattle.—The ordinary cows of the ryot, when in full milk, seldom give more than one measure of milk a day, and seldom yield milk for a longer period than six or seven months; but there is no good reason why they should not earn their food, by working at any rate during the time they are not giving milk. During a month or two before calving, and, for three or four months afterwards, it might be inexpedient to work cows, but during six months in the

year they might, as draught animals, earn their food. There are in this presidency, according to the latest statistics, about $8\frac{1}{4}$ million head of cattle; of these it may be fairly assumed that at least 2 millions are cows and heifers above two years of age. By working them lightly, 500,000 head of cattle, or from 10 to 15 per cent., might be added to the cultivating force of the country as it at present nominally stands. There are no objections to be raised against such a practice in the interests of the cow; it would rather in fact be for her advantage, the moderate exercise entailed thereby and the extra food given her being likely to keep her in better bodily condition and in better health.

During the year 1878, a cow of the Nellore breed was purchased chiefly with the object of using her in carts, so as to demonstrate the value of cows as draught animals. She was easily trained in a single cart and was generally used in light work, such as carting green fodder from the field, &c. She was worked until about two weeks before she calved. The calf—a heifer—was well developed when born and did not appear to have suffered in any way from the work its mother had to perform until just before its birth. The cow's daily yield of milk for some months afterwards was about $2\frac{1}{2}$ measures; the cow also rearing her calf. It will be a great boon to this country when the ryots can be induced to look upon their cows as draught animals and to use them as such. In some parts of Germany the small farmers use nothing but cows for the performance of agricultural operations, and even large landholders frequently use them for light work; but arrangement is generally made that the cows may calve at a time when little or no farm work can be performed, so that the yield of milk after calving, when they have no work to perform, is unaffected, and when they are put to work every day for half a day some months afterwards the yield decreases only slightly. It is considered generally that cows that are put to light work are more healthy than those kept always in the byre.

Two buffalo bulls of the Guzerat breed were constantly worked on the Farm for about ten years; they were most useful animals either for carting or ploughing, being admirably suited, on account of their enormous strength and steady action, for deep ploughing. There is a very general impression that buffaloes will not work during the heat of the day, but no more trouble was experienced with them than with ordinary plough cattle, while their keep was decidedly much less costly, as they ate any sort of coarse fodder, and were very hardy, being kept constantly in the open air tied under the shelter of a tree, their destructive propensities preventing their being placed in a shed. Being far superior to the Madras breed of buffalo in form and strength, it was hoped that they might do much good in improving it, but although they served many cows in the neighbourhood the results are not easy to trace. Only long continued, well directed, and persevering efforts can ever produce any very clearly marked improvements in the cattle or agriculture of any country.

Sundays excepted, the Farm cattle work daily in the cold season 9 hours, and in the hot season $8\frac{1}{2}$ hours. In the former they begin work at 6 A.M. and work until 10 A.M., when they are put into their stalls to

feed and rest until 1 P.M., at which hour they are again yoked, and are employed until 6 P.M., when the labor of the day ceases. The animals are then placed in their stalls, where they remain until the following morning. In the hot season their working hours are different. Instead of beginning work in the morning at 6, they start at 5-30, and in the afternoon, instead of beginning at 1, they do not begin until 2 o'clock. These hours are shorter than is usual in this part of India, though for a hot climate they are sufficiently long for both the cattle and their drivers. Before these regulations were adopted the working day on the Experimental Farm for the draught cattle was about 10 hours throughout the whole year; however, it was seldom that the animals performed 10 hours' work; for, though they might be in the fields or on the roads for 10 hours, they were not actually employed during the whole time, and it is better in every way that they should be comfortably lying in their stalls during the extra hour or hour and a half of leisure, which the present regulations afford them, than be standing for a similar length of time on the road-sides or on the headlands. The cattle are now in their sheds during the hottest part of the day, and they now do more than under the old system, being kept at work during the hours set apart for it.

The amount of labor performed in a day by a pair of these cattle with European implements has already been mentioned in a previous chapter. In England and on the Continent, where draught cattle are employed, teams of two or even four pairs of oxen are often yoked to implements; we here think one pair sufficient, except with a heavy grubber or in very deep ploughing; and in those countries the "alternate" or "half-day" system of working oxen is frequently adopted, while the animals generally have a month or two at grass during summer.

The cattle on the Farm are allowed 4 lb. of ground-nut oil-cake and as much chaff, consisting of green fodder or straw or a mixture of both, as they like per diem, a little salt being mixed with their cake. The cost of maintaining a pair for a year on this system may be put down as follows:—

	RS.	A.	P.
Fodder throughout the year, at the rate of 100 lb. a pair daily, valued at 400 lb. per rupee.	91	4	0
Cake throughout the year, at the rate of 8 lb. a pair daily, valued at Rs. 7 per 500 lb. ...	40	14	0
Interest on probable value of the pair of cattle, say, Rs. 100, at 5 per cent. ...	5	0	0
Deterioration, say, at 10 per cent. per annum, on Rs. 100, the value of the cattle ...	10	0	0
Shoeing throughout the year twelve times, at As. 12	9	0	0
Contingencies	3	14	0
Total Rs.	160	0	0

The total cost, Rs. 160, divided by 310, the number of working days in the year, gives a sum per diem amounting to 8 annas 3 pies as the actual daily cost of a pair of these draught cattle.

Milk production.—The necessity for improving the milk-producing powers of the cows of the country has already been referred to. Until 1874, the Farm itself possessed no milch cattle, and it was not until 1877 that the collection of data was begun on it; before that, however, data had been collected regarding the production of milk by cows in private possession of the officers connected with it.

The following is a record of the milk-producing qualities of an ordinary Nellore cow during the year 1871-72. The cow was an old one and was bought from a milkman who would have been very unlikely to sell her for 60 rupees had she been more than a very ordinary cow; indeed, when offering her for sale, all he could say for her milk-producing abilities was that she would give daily about two measures, and she had been for some time in his possession. At the time of purchase she had a calf about a month old, and was much out of condition; her live weight, ten days after she was bought, being only 536 lb. Her food was daily—4 lb. of ground-nut cake; 2 lb. of wheat bran; 20 lb. of green fodder (cholum, &c.); 15 lb. of grass; ¾ oz. of salt. She was allowed to graze for about a couple of hours in a compound each morning after being milked; during the remainder of the day and during the night she was tied up in a byre, and was always abundantly supplied with drinking water. She was milked at about seven in the morning and at about five in the evening. She ate her cake (steeped) and bran while she was being milked, and her calf was allowed to be near her at the time, being permitted to strip any milk left; after this was done the calf was not allowed to go near its dam until the milking hour again came round. The following details show the quantity of milk obtained during the 12 weeks over which the experiment extended:—

Week.	Mornings.		Evenings.		Total.			Week.	Mornings.		Evenings.		Total.		
	Mrs.	Olks	Mrs.	Olks	Mrs.	Olks	Pints.		Mrs.	Olks	Mrs.	Olks	Mrs.	Olks	Pints.
1st ...	10	2	8	5	18	7	54	5th ...	12	7½	10	5½	23	5	68
2nd ...	11	7½	10	4	22	3½	65	6th ...	14	7	11	7	26	6	77
3rd ...	12	2½	10	5	22	7½	66	7th ...	15	0	11	7½	26	7½	78
4th ...	11	6½	10	1½	22	0	63	8th ...	15	1½	11	2	26	3½	76
9th ...	14	6	10	5	25	3	73	11th ...	15	4	11	7	27	3	79
10th ...	15	3	11	4	26	7	78	12th ...	14	7	11	5	26	4	76

Referring to this cow it was observed:—

"While the yield of milk has increased, so also has the weight of the cow. In the space of four months 143 lb. have been added to her live weight, while the yield of milk has been doubled. 120 measures of most excellent milk is now obtained monthly, at a cost, for food and attendance, of Rs. 9-2-11, or about 1¼ anna per measure. Under the circumstances, I think I am fully justified in concluding that *the increase of* 50 *per cent.* in the yield of milk is entirely due to the feeding. The milk is unusually rich; it yields regularly 12½ per cent. by volume of excellent cream, and the yield of butter confirms this, as from two measures (6·63 pints) of fresh milk, five ounces of butter is now regularly obtained. This is equal to a yield of one pound of butter for 21·1 pints of milk. In England the average quantity of milk required to yield one pound of butter is 22 pints. The milk of the Alderney, the Kerry, and of some of the other small breeds of dairy cattle is much richer than this, though of their milk seldom less than 17 pints are required to yield one pound of butter; indeed,

I only know of one published instance in which a less quantity yielded one pound, and that was in a dairy of Kerrys grazed on the rich evergreen pastures of the south-west of Ireland; in that instance, 16 pints of milk regularly yielded one pound of butter."

In another case the produce of a cow, the result of a cross between a Devon bull and a Nellore cow, was recorded, commencing from the day the cow dropped her third calf, and extending over the whole period of milking. This cow calved again about two months after she ceased to give milk. Thus, in the period between her third and her fourth calves, she yielded milk during forty-four weeks and was dry during eight weeks. During the whole of this time her daily food consisted of—green fodder 40 lb., ground-nut cake 4 lb., wheat bran 2 lb., and about a dessert-spoonful of salt; the ground-nut cake was steeped and mixed with the bran, half being given in the morning and half in the evening; in other respects the treatment was the same as that in the case of the Nellore cow already referred to. In this case the return for the seventh week was 25 per cent. less than the yield of the previous week; this sudden diminution was due to the cow having been milked by a person to whom she was not accustomed, the man who usually milked her being absent owing to sickness; this change proved very unfortunate, for though, when the regular milkman returned to his duties in the thirteenth week, the yield somewhat improved, it was still very much below what it would have been had not the change referred to occurred. It is necessary to call particular attention to this fact, for, though some cows will give the same quantity of milk to any milker, it is well that it should be known that with some cows a change in their attendant may lead to a very large reduction in the quantity of milk obtained.

During the first four months of this experiment, the calf was allowed to take about one measure of milk daily and about half a measure during the next two months; this milk was of course not brought to account in the registrations. It is an advantage in this country to allow the calf access to its mother before and after milking, as is customary, for not only does the cow yield her milk more freely, but, what is of more importance, her udder is thoroughly stripped after each milking; and, with the help of other food, the calf can be reared at a very moderate cost.

The total quantity of milk yielded was 1,177 measures and 1½ ollocks, or 3,397 imperial pints. The quality of the milk was, throughout the whole period, exceedingly good, yielding by volume on the average from 11 to 15 per cent. of cream. The total expense of keeping this cow for the year amounted to Rs. 141-15-0; but from this must be deducted the sum, Rs. 25, realized by the sale of the calf, leaving Rs. 116-15-0 as the cost of 1,177 measures of milk, which is equal to 1 anna and 7 pies per measure or 6 pies a pint.

A yield of 424½ gallons of milk in the year is very satisfactory considering the conditions met with in this country. In Ireland, a cow of the Kerry breed, which is the favorite dairy breed in that country, will yield during the year from 450 to 500 gallons of milk; Mr. John Haxton in his book "*How to choose a good Milch Cow,*" says :—"Mr. Crosby's dairy of Kerry cows at Ardfort Abbey, near Trallee, averaged 42 in number during the seven years ending

with 1861, and averaged 488 gallons of milk a-piece per annum during that time, varying from 411 gallons in 1851 to as much as 542 gallons in 1856," and Mr. Morton in his "*Hand-book of Dairy Husbandry*," says:—"From these instances, it may be safely gathered that the average yield of well-managed cows varies from 480 to 600 gallons of milk a year, according to breed and size, the Kerry under good management yielding the former quantity, and the Yorkshire, short-horned, and cross breeds the latter."

A daughter of the cow last referred to, by a Nellore bull, calved when about three years old. The following registrations show her yield of milk per mensem during her milking period:—

—	Mrs.	Olks.	—	Mrs.	Olks.
1st Month	110	7¾	8th Month	102	6¼
2nd do.	114	6½	9th do.	70	6½
3rd do.	106	3	10th do.	56	4½
4th do.	111	3¾	11th do.	40	3½
5th do.	112	5¼	12th do.	27	5¾
6th do.	115	4¼			
7th do.	116	...	Total 3,134 pints or ...	1,086	1

Considering the age of the cow, the yield of milk was very satisfactory. This cow dropped her first calf on the 13th of August, when, as before noticed, she was only three years old. She was milked during nearly 48 weeks, and had her second calf scarcely twelve months after the birth of her first; thus, she had had two calves when just four years old. The foregoing facts show how much good can be effected by using bulls of a superior breed and by providing suitable fodder and other food in sufficient quantity for the cows throughout the year. As a general rule, the cows of this country seldom drop their first calf until they are five or six years old.

The Aden breed.—In May 1877 a commencement was made in collecting data from the cow already referred to as having been imported in 1874, and it was soon conclusively shown that she was a remarkably good milker. During this milking period, the first for which figures were recorded, she yielded 314 gallons of milk and reared a calf; her milk was remarkably rich, yielding butter at the rate of 1 lb. to every 16·3 pints of milk churned, and, although this was probably not so free from water, &c., as English butter is, the produce compares favorably with that of the best English breeds. After yielding milk for 5 months, the cow took the bull and calved again in June 1878, a month before her time, and milking was not begun till the middle of July. In the following year she calved at the end of August, and in 1880 at the end of July, but was attacked by foot-and-mouth disease in January 1881, when her milk was thrown away for about six weeks. She dropped other calves—in 1881 at the end of August, in 1882 early in October, and in 1883 in September—but had to be destroyed in March 1885.

The following table summarizes the amount of milk obtained from this cow, which went by the name of Sultana I.

Milking period beginning	May 1877.		July 1878.		September 1879.		July 1880.		August 1881.		October 1882.		September 1883.	
Yielded.	M.M.	Gals.	M.M.	Gals.	M.M.	Gals.	M.M.	Gals.	M.M.	Gals.	M.M.	Gals.	M.M.	Gals.
First Month ...	77·8	29·56	55·75	20·12	122·2	44·11	130	...	93·5	33·75	116	41·84	82·1	29·63
Second do. ...	64·2	24·39	75	27·07	112·5	40·61	130	46·93	113·5	40·97	125	45·12	95·3	34·46
Third do. ...	58·9	22·38	77·5	27·97	117·2	42·31	133·1	48·05	103·9	37·50	125	45·12	118·4	42·36
Fourth do. ...	56·2	21·35	75·5	27·25	81·8	29·53	151·2	54·58	95·75	34·56	110	39·71	112·7	40·68
Fifth do. ...	68·9	26·56	76·4	27·77	104·3	37·65	140·2	50·61	95	34·22	120	43·32	94·25	34·02
Sixth do. ...	72·6	27·36	81·6	29·45	82·25	29·69	140·2	50·61	79·6	28·73	119·7	43·21	64·7	23·35
Seventh do. ...	73·6	27·96	71·3	25·74	81·6	29·45	Sick; milk thrown away.		86·6	31·26	113	40·79	24·31	9·72
Eighth do. ...	85·75	32·58	73·1	26·39	78·7	29·24			89·1	32·16	89·25	32·22	12·06	4·82
Ninth do. ...	92·75	35·24	70·3	25·37	36·9	13·32	90·8	32·77	62·25	22·47	42·12	15·20	...	...
Tenth do. ...	82·9	31·50	...	...	...	...	90·6	32·70	...	...	...	...	...	...
Eleventh do. ...	84	30·24	...	...	...	...	...	...	...	...	...	...	...	...
Extra portions of months	15·4	5·85	37·6	13·57	13·7	4·94	89·1	32·16	24	8·66	64·12	23·14	23·3	8·41
Total ...	833·00	314·97	694·05	250·70	831·15	300·85	1,095·2	348·41	843·20	304·28	1,024·19	369·67	627·12	227·45

A heifer, Sultana II, dropped by last cow in June 1878, calved in November 1881 a fine bull calf, but unfortunately she was carried off

by anthrax in August 1882. Another heifer, Sultana III, dropped by the same cow in August 1879, calved a bull calf at the end of January 1882, when under 2½ years old, and continued to yield milk for over 18 months, yielding in all 1,121 Madras measures, or 404·28 gallons during her first milking period. She was very young when she calved and her yield of milk was most irregular, attaining its maximum in the twelfth month after calving. She calved again in October 1883, and has since yielded in 14 months 1,164·87 Madras measures of milk. Sultana IV was dropped by the same old cow in July 1880 and produced a heifer calf on 2nd April 1884 and had yielded 897·31 Madras measures (323·94 gallons) up to March 1st 1885 and was still giving over 2 measures a day.

Of the three cows imported from Aden in 1881, one was sold early in 1884 as she had not shown herself to be a good milker. The following figures show the milk record of these cows :—

Cow	Hameer.		Banu.		Rani.	
Date of calving	26th Oct. 1882.		26th Feb. 1883.		1st May 1883.	
Amount given in	M.M.	Gals.	M.M.	Gals.	M.M.	Gals.
First month	65·25	23·55	77·9	28·12	86·75	31·31
Second do.	76·5	27·61	85	30·68	89·75	32·4
Third do.	67·75	24·45	91·25	32·94	90·4	32·63
Fourth do.	59	21·29	91·6	33·06	80·7	29·13
Fifth do.	61·4	13·29	94·7	34·18	79·5	28·70
Sixth do.	60	21·66	99·9	36·06	74·75	26·98
Seventh do.	58·9	21·27	97·5	35·19	66·25	23·91
Eighth do.	44·75	16·15	97·9	35·34	27·6	9·95
Ninth do.	40·1	14·48	87	31·40	15·4	5·55
Tenth do.	39·25	14·17	89·1	32·16	10·6	3·82
Eleventh do.	30·25	10·92	79·9	28·84	...	...
Twelfth do.	25	...	54·4	19·63	...	...
Thirteenth do.	...	...	61·9	22·34	...	...
Fourteenth do.	...	...	55·5	20·04	...	...
Extra portions of months ...	12·1	4·36	18·2	6·57	12·55	4·53
Total ...	640·25	213·20	1,181·75	426·55	634·25	228·91

These records speak for themselves, but it may be remarked that the milking qualities of the Aden breed are vouched for by them.

The cost of maintaining cows of this breed may be calculated as follows :—

	RS.	A.	P.
11,000 lb. of green food	36	12	0
1,500 lb. oil-cake	21	0	0
730 lb. wheat bran	18	4	0
730 lb. dholl husk	11	6	0
20 lb. salt	0	10	0
Attendance and sundries	18	0	0
Interest on value of cow, Rs. 150, at 5 per cent. and depreciation at 10 per cent.	22	8	0
	128	8	0
Deduct one-third value of artificial food chargeable to manure	16	8	0
Net cost per annum...	112	0	0

No charge is made for the bedding supplied, as it goes back to the land as manure. The rate charged for green food is a profitable one to the grower ; and besides producing milk the cows would rear a calf worth Rs. 20 at least at the same time. The net cost of producing, say, 800 Madras measures of milk may then be taken at about Rs. 92, or 1 anna 10 pies a measure, say, 2*d*. a quart. The selling price in Madras varies from 3 to 4 annas a measure; the margin for profit is therefore considerable.

The system of management pursued with these cows is almost the same as that noted regarding the first cow referred to above, except that as far as possible the only fodder used is green, and preferably cholum fodder.

Kerry Cow.—In 1881 a cow was purchased in Madras which, though she is certainly not pure-bred, possesses many of the characteristics of this breed. During the first four months after her purchase she yielded 349⅝ Madras measures (125·67 gallons) and calved again immediately afterwards which she continued to give milk for 10 months; and then again after an interval of about 2½ months calved again to an Aden bull. Her milk record for the last two periods was as follows :—

—	First period.		Second period.	
Date of calving	6th October 1881.		28th October 1882.	
Yield of milk	M.M.	Gals.	M.M.	Gals.
First month	97·10	34·93	128·75	46·48
Second do.	98·60	35·47	159	57·40
Third do.	96·10	34·58	155	55·95
Fourth do.	71	25·22	138	49·81
Fifth do.	74·60	26·84	134	48·37
Sixth do.	75·75	27·34	135	48·73
Seventh do.	51·25	18·49	136·6	49·31
Eighth do.	47·4	17·10	126·55	45·68
Ninth do.	31·4	11·32	128·75	46·48
Tenth do.	...	...	114·5	41·33
Eleventh do.	...	...	105	37·90
Twelfth do.	...	...	99	35·74
Thirteenth do.	...	...	85	30·72
Fourteenth do.	...	...	88·6	31·98
Fifteenth do.	...	...	78·9	28·48
Extra parts of months ...	69·9	25·22	62	22·37
Total ...	713·10	256·51	1,874·65	676·73

Nellore breed.—This breed has a high local reputation for the dairy, and some milking records of Nellores have already been given, but they scarcely refer to fair specimens of the breed. In January 1882, however, two cows, average specimens, were purchased, each of which was about 4 years old and had a first calf about 3 months old at foot. They cost Rs. 100 each. They were large animals and needed about one-third more food than an Aden cow and indeed cost not less than 30 per cent. more to keep than cows of that breed. They are not nearly so docile as the Aden, for, whilst 3 or 4 of the latter may be safely penned together, the former must either be tied up or placed in separate pens. The yield obtained from these cows was as follows :—

Cow ...	Seetha.				Lutchmi.			
Period ...	1st.		2nd.		1st.		2nd.	
Beginning ...	January 1882.		April 1883.		January 1882.		June 1883.	
Ending ...	January 1883.		December 1883.		March 1883.		March 1884.	
Milk in	M.M.	GALS.	M.M.	GALS.	M.M.	GALS.	M.M.	GALS.
First month.	80·12	28·92	92·87	37·15	84·12	30·37	87·87	31·72
Second do.	86·25	31·13	24·75	9·90	82·12	29·64	91·00	32·85
Third do.	82·50	29·78	78·62	31·45	85·37	30·82	113·50	40·97
Fourth do.	86·87	31·36	66·62	26·65	85·50	30·86	97·62	35·24
Fifth do.	85·62	30·91	58·50	23·40	80·87	29·19	97·37	35·15
Sixth do.	64·87	23·42	56·50	22·60	67·50	24·36	93·50	33·75
Seventh do.	71·25	25·72	30·25	12·10	70·87	25·58	94·50	34·11
Eighth do.	69·00	24·98	...	...	73·37	26·48	73·25	26·44
Ninth do.	69·50	25·09	...	...	73·00	26·35	54·37	19·62
Tenth do.	58·50	21·11	...	...	62·62	22·60	...	...
Eleventh do.	46·00	16·60	...	...	58·25	21·02	...	...
Twelfth do.	28·25	10·19	...	...	45·00	16·24	...	...
Thirteenth do.	...	...	...	...	25·87	9·34	Sold March 27th, 1884, while still milking.	
Extra portions of months.	36·12	13·04	34·99	13·99	48·25	17·41	62·75	22·65
Total ...	864·85	312·25	443·10	177·24	942·71	340·26	865·73	312·50

Punganúr breed.—In November 1879 three cows of this breed, with their calves, were purchased at Punganúr with a view to making a trial of their milking powers. The breed has a considerable reputation for milking purposes in the presidency; but it is stated by some that none of the pure-bred cattle are now to be found. The animals obtained, except one, all however appeared to have characteristics distinct from the common small breed of cattle of Southern India. Besides being obtained for the purpose of trial, it was considered advisable to obtain some animals of this breed in order to keep before the students in the Agricultural College specimens of the different breeds common in the presidency, and it was hoped that, by crossing it with the Aden breed, it would be possible to effect an improvement, for it was soon found that as regards milking capacity the breed is very low. In the following table the produce received from these cows from the time they reached the Farm until they ceased to yield milk is shown :—

Months.	No. 1.		No. 2.		No. 3.	
	M.M.	OLLS.	M.M.	OLLS.	M.M.	OLLS.
December 1879	27	4½	31	4	...	
January 1880	35	2¾	37	4¾	...	
February „	32	4½	33	5½	25	7
March „	32	4½	33	5	39	5
April „	35	3½	37	6½	39	4
May „	40	2½	41	0½	37	4½
June „	38	1½	39	7	37	1
July „	29	5	26	2½	33	2½
August „	32	0½	7	3	33	6
September „	27	0	...		26	6½
October „	20	7½	...		21	1
November „	7	2½	...		9	5½
Total ...	358	7¼	288	5¾	305	3

This shows that the average monthly yield from these cows during the periods they were yielding milk was 30 measures 6 ollocks or 10·9 gallons. The breed appeared to be very hardy, but the cows were so wild that no European could go near them. All the cows were crossed with the Aden bull, but, seeing the poorness of the breed, it was determined only to retain one—No. 2—and to sell the others as soon as they calved. No. 2 cow calved in November 1880, dropping a promising calf by the Aden bull imported in June 1874, and No. 1 also calved at the end of February. At the beginning of March 1881, however, an offer having been made to purchase all the cows and calves together, they were sold, it being then considered that, when proper facilities for carrying on breeding operations are available, it would be better to obtain fresh stock. During the period after calving in November, cow No. 2 yielded milk as follows :—

——	Quantity.	
	M.M.	OLLS.
November, from 10th, 1880	51	2
December 1880	75	4
January 1881	75	2
February „	61	4
Total ...	263	4

These figures are more satisfactory than those obtained in the previous year, but it must be remembered that they refer to the period immediately after calving, and that the cow had been for a year under a course of good feeding and treatment.

Australian Cows.—In December 1878 two cows, which had been brought from Australia, were purchased in order to make an experiment in introducing such animals. They were cross-breds and about 6 years old, but both unfortunately died about 2 months after their arrival on the Farm and thus the experiment terminated. The following figures, however, show the amount and value of the milk obtained from the cows and the cost of feeding them whilst they were on the Farm until the date of their death :—

——	Yield of milk.		Value.			Cost of feeding.			
	M.M.	GALS.	RS.	A.	P.		RS.	A.	P.
December 1878 ...	283·4	113·4	47	3	9	146 lb. G. N. cake...	2	14	9
January 1879 ...	314·6	125·8	52	7	0	916 lb. bran ...	18	5	1
February 1879 ...	58·6	23·4	9	12	4	6,800 lb. green food...	22	10	8
						Attendance and sundries	9	0	0
	656·7	262·6	109	7	1		52	14	6

The figures show a net income of Rs. 56-8-7 during the ten weeks that the cows lived. The result shows how very valuable a property good dairy cows are, and were it not for the greater risk attending the breeding of English cows than those of indigenous breeds, the shortest way to the improvement of Indian dairy stock would be to

import cows from Australia. Under any circumstances it will be advisable to import some bulls of good breeds for crossing on the native stock, especially as the experience gained in this case showed that the death of the cows may have been due to preventible causes.

It may not be out of place to remark here that the adulteration of milk with water (if the water be good) is, after all, only a minor evil, the loss being only in the pocket. It is a far more serious matter if the milk has been obtained from a cow suffering from disease, or if the water the cow drinks, or that added to the milk, contain minute forms of organized life. Though the ill-effects of drinking the milk of a cow suffering from disease are not always apparent, especially in the case of adults, there are many well-authenticated cases in which disease and death have been traced directly to the ill-effects of drinking diseased milk, chiefly amongst children, who are the largest consumers of milk in its unprepared state. Recent microscopic investigations have revealed the fact that, if a cow is allowed to drink impure water (and few dairy cows drink anything else in this part of India) containing animalculæ, the same organisms may be found in its milk. It has been suggested that officers should be appointed to inspect the milk supplied to consumers in Madras, but mere inspection of the milk would be useless. The only effective way would be to inspect the dairy cattle and dairies, and to allow no milk to be sold for consumption except by licensed dairymen.

Useful though the lactometre is in ascertaining whether the quality of milk reaches a certain standard, it is not a trustworthy guide as a means of ascertaining the quantity of water fraudulently added to a sample, if the quantity added is less than 20 per cent. of its volume. Samples of pure milk contain water in various proportions from 80 to 90 per cent., and it is almost as easy for the dairyman to water the milk before it leaves the cow as afterwards, by giving the animal succulent watery food, and the milk would still be none the less pure.

Boroglyceride.—This antiseptic was discovered by Professor Barff and has been found most useful in preserving milk and other articles of food. The following are some experiments made with this substance. To a measure of fresh milk weighing 40 oz., three-fourths of an ounce of boroglyceride, previously made into a semi-liquid by adding a spoonful of hot water, was added and mixed through the milk, which was allowed to stand in an open vessel until the following morning, when the cream was removed and both it and the milk were perfectly sweet. On the next morning, 48 hours after the experiment began, the milk was found to be still perfectly sweet and some more cream had risen to the surface, which with that previously removed was made into butter. The experiment was closed on the fifth day, when both milk and butter were found still perfectly free from rancidity. The temperature during the time that this experiment was carried on is shown below :—

Date.	Maximum.	Minimum.
26th	106°	81°
27th	104°	81°
28th	104°	81°
29th	99°	78°
30th	100°	75°

The following are the results of some experiments made during January 1883. On the 2nd of that month two lots of 12 and 8 oz. of butter made from the previous morning and evening milk and again on the 3rd 8 oz. of butter made from the morning milk were taken, and treated as shown below :—

Number.	Month and date.	Butter taken.	How treated.	Observations and date.
		oz.		
1	2nd January...	12	Put into a dish and immersed in a solution composed of 1 part boroglyceride and 80 parts water.	10th January 1883.—The butter projected slightly above the level of the liquid; this portion was yellow, the portion immersed was white. The taste and smell of the butter were unobjectionable. 20th January 1883.—Color of the butter unchanged. Taste good, but smelt rather unpleasant; the portion above the solution beginning to putrefy and fungus appearing on it.
2	Do. ...	8	$\frac{1}{8}$ oz. of boroglyceride mixed with the butter.	10th January 1883.—The quality of the butter well preserved; both the taste and color good. 20th January 1883.—The taste of the butter defective; the color remained good excepting that it was less uniform.
3	3rd January...	8	Not mixed with boroglyceride; the butter kept as usual.	10th January 1883.—Taste fairly good, but smell bad. Color yellow on the outside, but white inside. 20th January 1883.—Quite unfitted for food, smell and taste very bad.

Some other experiments were made with vegetables, shell fish, chops, &c., and it was shown that they remained perfectly fresh for many days after immersion in solutions of various strengths of between 1 to 20 and 1 to 50. Boroglyceride promises to be of much use in India, especially in the dairy, as it will allow of skim milk being used for feeding calves after reserving the cream to make butter.

Butter-making.—In endeavoring to discover the best manner of making butter, the following are a few of many experiments made :—

1. (*a*) A measure of milk, which had been set aside from the previous night's meal, was, when churning commenced, at a temperature of 81°. The butter was a long time in appearing, and was collected with great difficulty, the total yield being only three-quarters of an ounce. The milk in this instance underwent no preparation before being churned; it was slightly soured, but this was caused by natural agencies.

   (*b*) Another experiment of the same kind (excepting that, in this instance, the milk was artificially heated to 110° just after being taken from the cow) was made with two measures of milk, and the total yield of butter was only one and a quarter ounces.

2. A measure of milk, fresh from the cow, was placed in the churn, its natural temperature at the time being nearly 100°; cold

water was added, reducing the temperature to 85°. After churning for upwards of half an hour, the butter at length appeared, but the total yield was only half an ounce.

3. (*a*) A measure of milk, immediately after it left the cow, was artificially heated to 110°; about one fluid ounce of churn milk from the previous churning was then added, and the whole placed aside in an ordinary milk bowl. Next morning when churning commenced the temperature was 84°. The butter was a very long time in appearing, nearly a full hour, and the total yield was only one and a quarter ounces. The quantity of churn milk used was evidently far in excess of the requirement; the milk had assumed such a coagulated condition, that it was exceedingly difficult to separate the butter from the curd.

(*b*) The experiment was again made with two measures of milk, less of the churn milk being used. The butter appeared in much less time, and the total weight obtained was four ounces.

(*c*) The experiment was again performed with the same quantity of milk, still less of the churn milk being used. The butter came within 20 minutes, and the yield was four and a half ounces.

(*d*) The experiment was repeated with the same quantity of fresh milk several times, with varying quantities of churn milk, until, with from six to ten drops per measure, five ounces of butter were regularly obtained, generally within fifteen minutes from the time of commencing to churn. In very hot weather a smaller quantity of churn milk was found to be enough, but in cold weather (when the temperature of the milk was less than 70°) one fluid ounce per measure was not too much.

Based on these experiments, the following advice is given on the subject. Immediately on receipt from the cow of the morning's milk strain and measure it, putting the quantity needed for butter in a tin can, which should then be placed over boiling water in an open chatty, on a charcoal fire, the milk heated to 120° and then emptied into a bowl. Before cooling add from six drops to one fluid ounce of churn milk per measure, as the weather is hot or cold; then place the milk aside in as cool a place as can be provided (a hot dry place being greatly preferable to a cool damp place). The milk obtained at the evening milking should be treated in a similar manner, excepting that a few additional drops of churn milk must be added. Next morning both lots of milk should be put together into the churn. If the temperature of the milk is over 80°, cold water should be added to it; but care must be exercised not to fill the churn more than two-thirds full. To keep down the temperature of the milk (which will rise during churning) the churn should be placed in a chatty of cold water, and churning commenced by raising and depressing the plunger—for the first five minutes, at about 50 strokes per minute; for the second five minutes, at about 80 per minute; and, when the butter begins to come, at about 120 per minute. Butter generally begins to appear in 12 or 15 minutes after commencing to churn. Do not remove any until a moderate quantity has accumulated; and then continue churning for

about five minutes after the first butter is removed, when a second supply may be taken out, and the churning again resumed for about five minutes longer, or until all the butter is finally obtained, the whole operation generally lasting from 20 to 30 minutes.

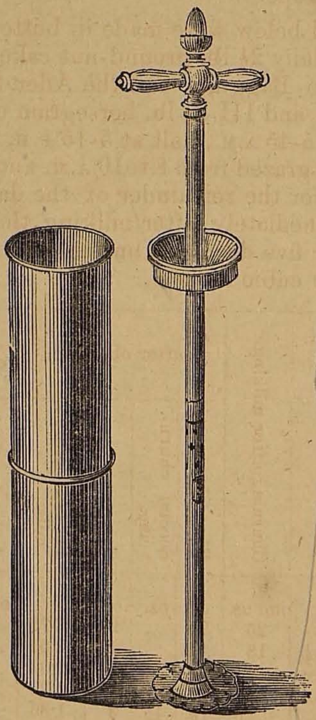


Fig. 29.

Great nicety is required in removing the butter and in manipulating it afterwards, and such a degree of cleanliness is demanded that one shudders to think of the preparation butter must undergo at the hands of the ordinary dairyman. After removal from the churn, the butter should be thoroughly washed with cool filtered water, and, during the operation, worked with a bamboo paddle. To facilitate the washing operation, cold water may be placed in a goglet fixed over the vessel containing the butter, the bottom of the goglet being perforated with holes of sufficient size to allow a gentle flow of water over the butter; the washings pass over the sides of the bowl, and can be collected in a vessel beneath. This operation, when carefully performed, need not occupy more than 10 minutes. In this manner as good butter as any ever tasted has been and may be made; the flavour of the essential oils being effectually preserved. If ice is used, butter-making is much less tedious.

The churn referred to is the Atmospheric churn shown in the annexed woodcut. It is of very simple construction and easily made up in any bazaar.

In the table given below, the results of a trial of one of these churns, together with those of another made on the principle of the barrel churn, are given. The results are much more favorable to the former, which appears to be very well suited to the requirements of South India.

Churns used.	Milk churned.	First churning.	Butter obtained.	Second churning.	Butter obtained.	Total butter obtained.
	OLLS.	MIN.	OZ.	MIN.	OZ.	OZ.
Brighton churn ...	$6\frac{1}{4}$	15	1	7	$\frac{1}{2}$	$1\frac{1}{2}$
Atmospheric churn.	$6\frac{1}{4}$	9	2	3	$\frac{1}{4}$	$2\frac{1}{4}$

An ollock is $12\frac{1}{2}$ cubic inches and contains about 5 oz. of milk, so the butter obtained was 7 % of the milk churned.

It has been noted that whilst the butter from Nellore cows is usually pale and white, that from the Aden's is a rich yellow, as is the case with the best dairy breeds in Europe.

In 1881, the experiments recorded below were made in butter and ghee making. All the cows received daily $2\frac{1}{2}$ lb. ground-nut cake, 4 lb. bran, and 30 lb. green food, but to Baggium and the Aden $2\frac{1}{2}$ lb. planter's friend seed, and to Sultanas I and III $2\frac{1}{2}$ lb. horsegram extra; half the artificial food being given at 5-45 A.M., half at 5-15 P.M. They were watered at 7 A.M. and 3-30 P.M.; grazed from 8 to10 A.M. and from 3-30 to 5 P.M., and kept in the sheds for the remainder of the day and milked at 6 A.M. and 5-30 P.M. Immediately after milking the milk was poured into a tin can and four or five drops of butter-milk added for each Madras measure of milk (100 cubic inches).

Date.	Cow from which the milk was obtained.	Milk used.		Churning after milking.	Butter obtained.				Ghee obtained.	
		Morning.	Evening.		First churning.	Second churning.	Total.	Per cent. of milk.	Amount.	Per cent. of butter.
		oz.	oz.	HOURS.	oz.	oz.	oz.		oz.	
28th April ...	Mixture from all cows.	$91\frac{7}{8}$	...	25	$2\frac{1}{2}$	...	$2\frac{1}{2}$	2·72	...	...
28th „ ...	Do. ...	...	$61\frac{1}{4}$	18	$1\frac{1}{4}$	...	$1\frac{1}{4}$	2·04	...	...
28th „ ..	Do. ...	$61\frac{1}{4}$	...	1	$1\frac{1}{4}$	...	$1\frac{1}{4}$	2·04	...	...
1st May ...	Do. ...	$156\frac{3}{4}$	...	25*	$2\frac{1}{2}$	$1\frac{3}{4}$	$4\frac{1}{4}$	2·71	...	...
1st „ ...	Do. ...	$160\frac{3}{4}$	...	1†	$1\frac{1}{2}$	$1\frac{1}{2}$	3	1·86	...	...
1st „ ...	Do. ...	...	$160\frac{3}{4}$	15	$4\frac{1}{2}$	$3\frac{3}{4}$	$8\frac{1}{4}$	5·13	...	...
5th „ ...	Baggium (Kerry). ...	$61\frac{7}{8}$	...	25	$2\frac{1}{4}$	$\frac{3}{4}$	3	4·84	$1\frac{7}{8}$	62·50
5th „ ...	Do. ...	...	$37\frac{1}{8}$	15	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{4}$	2·02	$\frac{3}{8}$	50·00
6th „ ...	Bonu	$72\frac{3}{4}$	...	25	3	$\frac{1}{4}$	$3\frac{1}{4}$	4·46	2	61·53
9th „ ...	Lutchme, Grey ...	$76\frac{1}{2}$	...	25	$3\frac{3}{4}$	$\frac{1}{2}$	$4\frac{1}{4}$	5·55	$2\frac{1}{2}$	58·82
11th „ ...	Sultana I	$47\frac{1}{2}$	...	25	$3\frac{1}{2}$	...	$3\frac{1}{2}$	7·36	$2\frac{1}{4}$	64·28
11th „ ...	(Aden) „	...	$32\frac{5}{8}$	15	$1\frac{1}{2}$	$\frac{1}{2}$	2	6·13	$1\frac{1}{4}$	62·50
13th „ ...	Sultana II	$57\frac{1}{16}$	...	48	4	...	4	7·00	$2\frac{1}{4}$	56·25
13th „ ...	(Aden) „	...	$54\frac{6}{16}$	38	4	...	4	7·36	2	50·00
16th „ ...	Sultana III	$67\frac{1}{2}$	...	51	$4\frac{1}{4}$	...	$4\frac{1}{4}$	6·29	$2\frac{1}{4}$	52·94
16th „ ...	(Aden) „	...	54	39	$3\frac{1}{4}$	...	$3\frac{1}{4}$	6·01	$1\frac{1}{2}$	46·15
16th „ ...	Do. „	$59\frac{5}{16}$	...	26	$2\frac{1}{2}$	...	$2\frac{1}{2}$	4·21	$1\frac{1}{4}$	50·00
16th „ ...	Do. „	...	54	15	3	...	3	5·55	$1\frac{1}{2}$	50·00

* Milk was heated after being drawn. † Fresh milk.

In the next table the results of some further experiments in butter and ghee-making are given. They were obtained in July 1884. The cows were fed in the same manner as related above, the green fodder supplied being Guinea-grass.

Cow from which the milk was obtained.	Milk used.				Churning after milking.		Butter obtained.				Ghee obtained.		Remarks.
	Morning.		Evening.		Morning.	Evening.	First churning	Second churning.	Total.	Per cent. of milk.	Amount.	Per cent. of butter.	
	MRS.	OLL.	MRS.	OLL.	HOURS.	HOURS.	OZ.	OZ.	OZ.		OZ.		
Mixture from all cows.	4	0	4	0	23½	17	21½	6	27½	11·6	19¾	71·8	The surplus milk after distribution was used. Part of the cream may have risen to the surface before distribution was over and been lost. To the raw milk, churn milk was added.
Kerry cow ...	2	2	2	1	51½	40½	10¾	2½	13¼	10·3	8	60·3	Both morning and evening milk was treated with a teaspoonful of boro-glyceride and kept two days. Butter was tolerably fresh.
Do. ...	2	1	2	0	26¼	16	14¼	⅜	14⅝	11·6	10½	71·8	To the raw milk, 6 drops of churn milk per measure were added.
Do. ...	1	6½	1	5	26¾	17	12¾	...	12¾	12	8¾	68·6	Both morning and evening milk was heated by boiling water to 120° F. and 12 drops of churn milk were immediately added.
Do. ...	2	1	1	5½	26	15¾	14⅝	⅝	15¼	13·1	11¼	90	There must have been some error in weighing the ghee or otherwise; to the raw milk, churn milk was added.
Do. ..	2	1	1	5¾	26¼	16	12¾	1¼	14	12	8¾	62·5	Both morning and evening milk was heated to 120° F. by boiling water and 12 drops of churn milk were added immediately.
Do. ...	2	1	1	6½	27½	17½	13¾	1¼	15	12·9	...	...	Churn milk was added only to the evening milk.

The percentage of butter obtained was very high and probably a good deal of the curd was mixed with it. Considerable difficulty is experienced in making the butter owing to the high temperature which usually prevails, and as this causes more or less melting, the difficulty of making the butter is greatly increased.

In November 1882 some experiments were made in ghee-making with the milk of the Kerry cow Baggium. The milk was churned 24 hours after receipt, having, as soon as it was drawn, been heated to about boiling point and a little buttermilk being added. The ghee was made as follows :—

The butter is melted in an open vessel over a slow fire ; the heat coagulates the casein, which, with other impurities, sinks to the bottom of the vessel: boiling is continued for from fifteen to twenty minutes, when most of the water is evaporated, and the ghee, clear and bright, rests on the heavier sediment covering the bottom of the vessel. The ghee, when cold, is carefully poured off, leaving the sediment behind, and is fit for immediate use, or for storing.

The following were the results :—

Milk drawn.	Milk used.	Occupied in first churning.	Butter obtained.	Occupied in second churning.	Butter obtained.	Total occupied in churning.	Total quantity of butter.	Quantity of ghee obtained.
Morning.	MS. OL.	MINS.	OZ.	MINS.	OZ.	MINS.	LB. OZ.	OZ.
29th	2 4	25	6¾	10	¼	35	0 7	3¼
30th	1 2	16	4½	4	¾	20	0 5¼	2¾
30th	5 0	25	20½	10	½	35	1 5½	10½

The yield of ghee made from the cow butter varies generally from 50 to 60 per cent., but it is not usually made when a fair price can be obtained for butter. A viss (3 lb. 2 oz.) of ghee sells usually for only about Rs. 1-2-0, and to make this, not less than 6 lb. of butter, or 48 quarts of cow's milk would be needed. In nearly all the large towns of Southern India cow's milk will sell readily at Annas 2 a quart and butter at Annas 12 a pound. Thus the milk that would be required to make a viss of ghee worth Rs. 1-2-0 would, as fresh milk, sell for about Rs. 6 ; and, if churned, would yield butter worth Rs. 4-8-0.

Cheese-making.—Several experiments have been made in this direction and it has been found that the fresh juice of the *Epicarpurus Orientalis* (Prayam) is as good a coagulant as English Rennet extract ; the juice of sixteen leaves being sufficient for a Madras measure of milk. In three hours, milk treated with this juice has been found to be changed into a firm cylindrical block of curd with a layer of dense supernatant whey. It does not affect the flavor of the cheese, nor does it require preliminary preparation, and it is procurable at all times. It appears to be superior to the seed of the *Withania somnifera* (Puneria). The leaves have to be used fresh. It has thus been found possible to procure firm solid curd ; and there is apparently no practical difficulty in preparing and drying curd for immediate consumption, but the

great difficulty is to prepare curd in a way to fit it for keeping the requisite time to undergo the ordinary changes which the cheese manufacturer includes under the term "ripening." In England this occupies several months; but the so-called cheese made in these experiments could not at the time when the experiments were made (the hot season) be kept for a week, putrefaction setting in so rapidly accompanied by luxuriant fungoid growth. Perhaps the addition of some antiseptic, boroglyceride for instance, may improve the keeping quality of newly-made cheese. On the average about three measures of milk were required to make 1 lb. of the cheese, and if the ripening processes could be conducted satisfactorily to completion, which could readily be done at Bangalore or at any of the hill stations, cheese might be produced for sale at under half a rupee per pound. Of course, where milk can be sold at 4 annas a measure, it will not pay to make cheese at that rate even when it is possible to cure it.

SHEEP.—The breed kept is called the Saidápet breed. The foundation of it can be traced to a mixture of the Patna, Nellore, Mysore, and Coimbatore breeds. The proportion in which the flock was originally mixed is not known; but in 1868 there were only 11 Patna ewes in the flock of 75: two rams, however, of the same breed seem to have been largely used in crossing at that time. The flock was, however, nearly trebled in 1869 by the purchase of a large number of country ewes, so that the proportion of good animals was reduced. From this number, the ewes were selected to form the nucleus for the flock from which the breed descended directly, no new blood having been introduced until 1880; the improvement which had till then been effected having been brought about by carefully weeding out inferior sheep and by the use of the best rams available. In fact a system of in-and-in breeding was followed.

In the early days of the experiment, 1870, it was found that the Nellores did not thrive so well on artificial keep as the Patna and Mysore breeds; during the dry parching weather experienced in April, May, and June, a considerable number of Nellore sheep died, and the whole of them fell much out of condition, while the Patna and Mysore sheep, the Patnas more particularly, though grazed with the Nellores and fed on the same food, suffered very little, and kept always in fair condition. A few Mysore sheep died; but very few in proportion to the number of Nellores. Of all these breeds—Nellore, Patna, Mysore, and Coimbatore—the Patna is undoubtedly the best. It comes to maturity earlier, feeds more rapidly, and gives a greater percentage of mutton.

In August 1880, after the flock had been reduced to half its former strength by the ravages of an outbreak of sheep-pox, two half-bred South-down-Mysore rams were purchased from the Mysore stud farm at Kunigal. They were well made animals, showing a good many of the characteristics of the South-down breed, but although their wool was far superior to that of the original Saidápet breed, a good deal of hair was mixed with the fleece. The lambs obtained from these rams are promising and their wool is of better quality than those bred before, and they show more character than those bred formerly did.

The chief characteristics of the Saidápet breed are that it comes earlier to maturity, gives a larger yield of mutton for the food it consumes, has a much better constitution than any known native

breed and the covering of wool is fair, but, as must be expected in these scorching plains, not of first-rate quality. In 1872 it was observed regarding sheep of this breed :—

"We have produced two year old sheep, weighing from 110 to 120 pounds live weight, capable of yielding 50 lb. of mutton, worth (at Annas 4 per lb.) 12½ rupees ; and these are from a flock of country ewes, many of which at the time the experiment commenced would not have realized 2 rupees each in the market. Indeed, nearly 100 were sold at prices ranging between 1¼ and 2 rupees per head, some difficulty being experienced in getting even these prices."

In the next year a few sheep of this breed, which in size and form had not fully realised the expectations formed concerning them, were killed for mutton with the following results :—

—	Average weight.	Percentage of total.
	LB.	
Legs	10·66	24·51
Loins	15·33	35·25
Shoulders, necks, and breasts ...	17·50	40·24
Total weight of mutton ...	43·49	100·00

None of these sheep had been specially fattened; they had been fed along with and in the same manner as the store sheep. They were in good average condition, their mutton being tender and well mixed with fat. The weights are not great; indeed, they could have been greatly increased had this been desirable; neither were the joints unusually heavy ; the mutton was worthy of notice rather for its fine grain, its fair proportion of fat and lean, its flavor, and the large proportion of flesh to bone, than for anything else.

There are now on the Farm some excellent sheep of this breed, and, what is equally satisfactory, the sheep are perfectly hardy and quite fitted for the hottest climates. Though as the experiment proceeds the quality of the sheep gradually improves and the good points which characterize the breed gradually become more fixed, a good many years must yet elapse before the breed can become thoroughly established. In view to the saving of time, it would be well to procure from Northern Australia or Southern Europe a few rams of a short-woolled breed, in order that by judicious crossing the desired results may be hastened.

Management of the Flock.—In the early days of the Farm it was arranged that the lambing season should commence shortly after the rains, when there is abundance of grass ; but, owing to the ewes consuming a large quantity of this quick-grown succulent fodder their milk being rendered injurious to young lambs, many deaths were caused: since then the lambing season has been made to commence at about the end of January. The management of the ewe flock is as follows ; it is generally sorted over once a-year, those animals of a bad form or color, or otherwise inferior, as well as any that have lost their teeth, being taken out of the flock and put aside for fattening or sale. In September the ewes that remain in the flock, with a number of gimmers then about thirty months old, are put with the rams, about

forty ewes being allowed for one: the breast of the ram is colored to mark the ewes in a way that enables the shepherd to detect readily those which have been served. The lambs are born about five months after, about 90 per cent. of the ewes generally proving to be in lamb. The ewes when about to lamb are placed in covered pens, where they are kept until their lambs are about three weeks old, after which they are again put with the flock in the sheep-fold. All males that do not promise to turn out well are castrated when about six weeks old, or are sold as lambs. When about three months old the lambs are weaned from their mothers, about a fortnight's separation sufficing for this, after which the wether and gimmer lambs are grazed in the flock with the ewes, the ram lambs being placed by themselves.

During the season of the year when night dews are heavy, the sheep do not leave the pens in the morning until the greater part of the dew has disappeared; it having been found, when the sheep were turned out early in the morning to feed upon grass heavily covered with dew, that a number of them were invariably attacked by dysentery of a severe type. During the hottest part of the day the sheep return to the fold for a few hours, and again go to graze until about five in the evening, when they again return and receive about half a pound of ground-nut cake per head, and are shut up for the night. During very dry weather they receive, in addition to the cake, a small quantity of green food, but they are maintained chiefly by the food they gather when grazing. Sheep thus fed are kept in a thriving condition; they are, of course, not fit for the butcher, but they are generally in the condition that it is most desirable for breeding stock to be.

The sheep are generally shorn in April or May, which is the best time of the year for the purpose. When the ewes are being clipped, it is usual to mark the lambs in a way to render their identification easy; in the farm flock this is done by cutting a small notch with a pair of shears in the cartilage of one ear of each.

An attempt was made in 1874 to introduce the Chinese breed of sheep, with the intention of using it for crossing on the Saidápet breed. The experiment proved that the heat of the climate is too great for the sheep of this breed, even when every care was taken to keep them from direct exposure to the heat of the sun. This result was unfortunate, as the breed possesses many valuable qualities, some of which it is desirable should be stamped on the sheep of Southern India: amongst these characteristics are a great length and depth of frame; ribs remarkably well arched; a fair yield of very fine and lustrous wool; and great prolificacy.

Wool production.—When sheep-breeding was commenced, the wool yielded by most of the sheep was exceedingly coarse and almost straight; it is now much finer and more a true wool. There is, of course, very much yet to be done before the average quality of the wool will be good, but the improvement that has been effected is very encouraging.

At one time it was feared that in this climate but little could be done towards improving the quality of wool; but, though intense heat is a great drawback, we possess one advantage over people resident in a cold climate in being able to grow crops throughout the year for sheep-food, and this is a very important advantage in wool-growing.

When sheep are alternately starved and overfed, their wool is always very irregular in strength and quality, the portion produced during the period when food is scarce being always weak. As our experiments have shown that we can produce green food throughout the year, there is no reason why we should not ultimately produce fine wool. It must be remembered that some of the finest wools produced in the world are grown in countries where the temperature has a very high range, in Australia for instance.

In 1872 the following valuation of the wool of this breed was made by a professional London wool-broker.

"The two samples of wool sent to us for valuation are 'fair East Indian yellows,' worth here from 11*d.* to 11½*d.* per pound."

In comparison with the value of the wool produced in the colonies, this wool is certainly not a valuable kind, still the difference in value is not so great as might have heen expected. Thus, when this wool was valued, the following rates were quoted in the London Wool Market Report :—

		s.	*d.*
Queensland and New South Wales, Ordinary, per lb.	...	1	2
Victoria Do.	...	1	3
Tasmania Do.	...	1	3
New Zealand Do.	...	1	2

The best colonial wool in unbroken fleeces was then selling at from 2*s.* 4*d.* to 3*s.* per pound. The rates quoted above are for wools classed as "broken pieces and locks," to which class the wool submitted for valuation belonged.

In 1877, when the experiment may be said to have been in operation for more than nine years, statistics of the wool production of the sheep of the flock were first collected in detail. They were repeated in the years 1879 and 1884 and are given in the following table :—

—	1877.			1879.			1884.		
		Average.			Average.			Average.	
	Number.	Weight.	Yield of wool.	Number.	Weight.	Yield of wool.	Number.	Weight.	Yield of wool.
Rams.		LB.	LB.		LB.	LB.		LB.	LB.
Lambs	38	28	...	...	...	...	2	...	...
Lambs, six months ...	...	...	...	...	...	...	21	30	1·0
Shearlings	31	47	1·76	18	47·2	1·55	5	43·2	1·4
2 Shear	16	66	2·28	25	66·5	1·56	5	76·4	2·5
Other ages	23	69·5	1·94	30	81·5	1·66	6	113·7	3·5
Average	70	58·74	1·94	73	67·9	1·60	37	48·3	1·6
Ewes.									
Lambs	27	25·6	...	...	...	...	...	...	...
Lambs, six months ...	...	...	...	...	...	...	23	28·3	·81
Shearlings	34	39·6	1·6	26	43·8	1·42	...	...	...
2 Shear	23	48	1·77	36	57·3	1·63	17	51·6	1·40
Other ages	84	53·17	1·31	83	61·1	1·63	38	67·5	1·65
Average	141	49·05	1·45	145	57·0	1·59	78	52·5	1·3
Average of sheep of all ages	211	52·27	1·62	218	60·6	1·59	115	51·2	1·42

In 1877 it was observed that "the wool produced this year shows on the whole an improvement in quality, and the sheep were far better covered, there being an absence of the bare necks and breasts that were formerly so common." The value of the wool in the local market had then increased considerably, for, instead of only 1½ annas per pound—the rate obtained in 1871—2½ annas were realized, showing an increased value of 66 per cent. The yield of wool per sheep did not average quite as high as the clip did in 1871, when 120 sheep averaged 1·81 lb.; this being probably due in a great measure to the scarcity of grass with which the season had been characterized, whilst the number shorn was nearly double.

In 1879 the average live weights were much more favorable, but the yield of wool was rather less. In 1884 the normal proportion between the ages of the sheep composing the flock had been disturbed; lambs six months old forming 38 per cent. of it, instead of a similar number of shearlings over one year old.

In 1877, for every 10 lb. live weight, the sheep produced on an average 4·95 oz. of wool, and in 1884 4·4 oz.; amounts which compare not unfavorably with that yielded by the English short-woolled breeds of sheep, especially when it is remembered how dry the wool is here at the shearing season. The following table shows the yield of wool per 10 lb. live weight by sheep of the different sexes at various ages.

—	Shearlings.		2 Shear.		3 Shear.		Aged.		Average.	
	1877.	1884.	1877.	1884.	1877.	1884.	1877.	1884.	1877.	1884.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Rams ...	5·99	5·1	5·53	5·2	5·21	5·1	4·09	3·7	5·28	5·3
Ewes ...	6·46	...	5·90	4·3	5·23	4·4	3·85	3·4	4·73	3·9

Pigs—were for many years kept on the Farm, the breed having been derived from imported English pigs picked up in Madras and from ships visiting the port. If pigs receive proper attention, there is, perhaps, no more useful agricultural stock in this country, but, as generally managed, they are the scavengers of the villages; hence the disrepute into which country pork has fallen. It should, however, be generally known that the cattle and sheep of the ryots, when kept in a half-famished state, are quite as filthy in their habits. Pigs that are properly housed and fed are almost as cleanly in their habits as cattle or sheep under similar conditions. They are admirably suited to supply the wants of European households on coffee estates and in other places where it is almost impossible to get butcher meat fit to eat, as they can be reared under conditions quite unsuited for rearing sheep, and under artificial feeding a pound of pork can always be produced at a very much lower cost than a pound of mutton.

In 1873 the following statement, referring to four small well-fattened pigs, was prepared; it shows the proportion of each kind of joint that the pigs afforded:—

—	No. 1.	No. 2.	No. 3.	No. 4.	Average weight.	Per cent. of average total weight.
	LB.	LB.	LB.	LB.	LB.	
Legs	20	19	16	23	19·50	21·82
Loins	40	35	40	44	39·75	44·48
Shoulders	18	17	16	24	18·75	20·98
Necks and breasts ...	12½	10	14	9	11·37	12·72
Total weight of pork ...	90½	81	86	100	89·37	100·00

It will be observed that the coarser and inferior parts of these pigs (necks, breasts, &c.) weighed less than 13 per cent. of the entire weight of pork yielded by each pig; this was very satisfactory, as it proved that the stock on the Farm had not degenerated, though it was many years since the original stock had been brought from Europe.

Originally the pigs were kept in ordinary styes floored with asphalte, the styes being provided with urine tanks; this arrangement was in operation for several years, and seemed to be as good as could be devised; however, the results never were satisfactory. The urine made ruts in the asphalte, and never passed entirely into the tanks, stagnating on the floors and causing a very offensive smell in the proximity of the styes; but the chief fault was a liability of the pigs reared in these styes to go lame, generally when about half grown; so common was this, that it was only with the utmost care that it was possible to rear a sound pig; covering the asphalte with sand or with straw was alike useless, for owing to the slope of the floors the covering always washed down from the higher level. It is difficult to explain why asphalte is thus injurious to pigs; probably, the injury is, to some extent, due to the non-absorptive property of the substance, moisture remaining a long time on its surface during damp weather, and thus causing rheumatism and similar complaints, to the attacks of which pigs are very liable.

Asphalte having been found to be unsuitable for flooring, it was determined to try the loose-box system, which had already been found to produce such good results with cattle. The results were so satisfactory that afterwards pigs were always kept in loose boxes with ordinary earthen floors. The boxes varied in area from 200 to 400 square feet; the former being the size allowed for a large sow and litter, the latter for five or six half-grown sows or hogs. The roof of the shed first used in this manner was supported on brick and chunam pillars about 6 feet in height, a rail fence about 4 feet high surrounding the whole building, and the divisions or boxes being formed by partition railings. The floors were sunk about 1½ feet below the level of the surrounding ground, precautions being taken to prevent surface water from flowing in; and the eaves of the roof projected about 2 feet, so that the roof water fell clear and did not get into the bedding. At starting, a layer of ashes was spread over the floor of the box, and afterwards bedding to the depth of 5 or 6 inches. The pigs were then allowed to enter the pens. On this system in the course of a few days the bedding is trodden down to half its former height and is more or less solidified according as the pigs are large or small. It is then only

necessary to add a slight surface dressing of bedding when needed. In this way both the liquid and solid excrements are retained in the straw, and the under-stratum made into an excellent manure, the surface being as clean-looking as could be desired, while there is an entire absence of smell.

At one time several of the best sows appeared to have become permanently barren, and thoughts were entertained of selling them to the butcher. Their diet was changed several times, and more exercise was given them; but no good results followed. As a last resource they were supplied daily with a few pounds of cholum fodder in a green succulent state ; the results were as satisfactory as could be desired. Probably any succulent vegetable would answer the same purpose as cholum. The only caution to observe is not to give so much green food as will cause any irregularity in the digestive organs of the animal.

Great care must be taken at certain seasons of the year to protect pigs from the sun, for they are far more liable to its injurious effects than is generally supposed. If exposed they are liable to suffer from apopletic attacks, which very often carry them off ; if taken in time the best treatment is the application of cold water.

An unsuccessful attempt was made in 1874 to introduce some Chinese pigs ; for although two boars, two sows, and four young pigs of the smaller breed were received in good health, the original importations succumbed to the heat, and their cross-bred progeny to disease of the lungs.

POULTRY.—A cross between the Brahmapootra cock and the Dorking hen, imported from Sydney in 1868, was highly appreciated. These fowls were widely spread over the presidency. In appearance, they were more like the Brahmapootra than the Dorking, being about the size of the former, with generally dark grey plumage; they frequently had yellow legs, seldom but more than four toes on each foot, and were generally heavily feathered about the feet and lower part of the legs. They throve well in the plains, and during the hot season did not appear to suffer more than indigenous breeds of poultry. When properly fed they were good layers and their eggs were much larger than those of the country hen. They could be fed up to six or seven pounds weight at nine or ten months old ; their flesh was good, but not quite equal to that of the Dorking.

Four chickens from one brood, when four months and three days old, averaged $4\frac{1}{2}$ lb. in weight ; these chickens, however, were fed on hard boiled eggs, raw meat, bran, paddy, &c., and were of a much larger size than is usually obtained under ordinary feeding. To illustrate the great importance of giving proper food to fowls, a brood of chickens was divided, one-half was fed according to the usual native custom, that is, the chickens were left pretty much to themselves, and had only an occasional handful of paddy or rice thrown to them ; at six months old, these chickens only averaged $2\frac{1}{4}$ lb. per head ; whilst the others which had been regularly fed, though only on very ordinary food, averaged nearly 4 lb. per head.

Ground-nut oil cake mixed with bran in the proportion of one to two by weight, forms a most excellent diet for fattening poultry. Fowls fatten rapidly on this food, and the flesh of those so fed is superior to that of grain-fed fowls.

With the exception of some Brahma-Dorking birds given to the people of the Wudder settlement, as narrated below, it has been usual to charge full value for poultry distributed by the Farm, but if it be found possible to extend largely the practice followed in the case of the Wudders and to distribute male birds of improved breeds gratuitously to the headmen of villages under certain conditions, a great amount of good may probably be done at a very moderate cost. It is true that in many localities, from the absence of natural food during a considerable period in the year, and the neglect of the people in providing proper food, superior breeds of poultry would degenerate; but there are many localities in which natural food is abundant throughout the greater part of the year that might be selected for the experiment suggested.

The experiment already referred to was commenced in 1871 in a Wudder village, at that time situated on the Farm estate, the object being to improve the breed of fowls reared by the villagers for the market. The village contained about 150 families of Wudders, and the greater number of these kept fowls. The Wudders promised that, if a certain number of cocks of the improved breed were supplied to them, they would take great care of them and would not sell or kill them, while they would kill every cock of the country breed belonging to the village. Of this experiment it was observed in 1872:—

"They have kept their promise very fairly. There are still a few cocks of the old breed in the village, but these they promise to kill as soon as the full number of cocks promised to them has been supplied. At first the experiment promised to be anything but successful. Several of the first batch of birds died shortly after they came into the possession of the Wudders; for a time it was difficult to understand this; however, a little inquiry convinced me that it was entirely owing to the wretched accommodation provided for the fowls at night. I found that eight or nine, and sometimes more, fowls were confined from sunset until sunrise in a brick and mud erection measuring about 3 feet each way outside measure, and certainly not containing 8 cubic feet of space inside. This place, as soon as the fowls were put inside, was almost hermetically sealed, there being scarcely a single aperture for ventilating purposes. The dead birds presented all the appearance of having been suffocated. It was not in the least surprising that birds which had been reared with care, and which had been housed at night in a well-ventilated apartment, should be suffocated in the place provided for them by the Wudders, even though, in these same places, fowls of the country breed seemed to suffer little or nothing. However, the difficulty of getting ventilation without admitting snakes and other foes to the birds has been overcome, chiefly, I believe, by introducing a long bamboo tube in the roof of the roosting place. The fowls now appear to be thriving. There are, at the present time, about 150 chickens of the new cross. These chickens are generally light-colored, and are much larger than chickens of the country breed."

A year later on the same subject it was remarked:—

"The experiment in improving the breed of poultry in the Wudder village has not been attended with as good results during the past year as could be wished. The people cannot, or will not, separate the half-grown fowls from those that are fully grown; the consequence is that the young hens begin to lay before they ought, which is most effective in putting a stop to any further growth. Early breeding is the great difficulty. The results of the experiment are, however, so far satisfactory that a 6-months'

old half-bred fowl is as heavy as a 12-months' old country fowl. To ascertain what had been done towards improving the breed of fowls in the village, the people were asked a few months ago to exhibit their half-bred poultry at the farm yard on the Experimental Farm, a promise having been made to them that a number of small prizes would be distributed to the owners of the best birds. There were 30 entries for the competition; these consisted of cocks 20, hens 27, chickens 20; total 67. Several of the birds shown were really very good. The people said that they would have been able to have exhibited a very much larger number of half-bred poultry had not great numbers been stolen from the village during the few weeks previous, and they added that it was only by the exercise of great watchfulness on their part that they were able to keep any of their fowls of the improved breed, as thieves were so frequently on the look out for them. They requested that they might be provided with a further supply of cocks of the European breed. As long as the people attach so much importance to early laying, we cannot effect any lasting improvement in the breed of poultry kept by them. At the time the poultry were being exhibited in competition for prizes, I was sorry to notice how anxious the people were to direct attention to what they considered valuable in the half-bred fowls, namely, their early laying propensities: one man seemed much disappointed because he did not get a prize for a fowl he exhibited, which he declared was only three months old, and yet had laid several eggs; the hen was probably a little older than the age mentioned by its owner, still it was but a chicken, and was permanently spoiled by laying so early in life. The eggs exhibited of the half-bred fowls were not so good as I had expected to see; indeed, they were but very little larger than the ordinary country eggs; however the birds which laid them were all very young, and the size of the eggs will doubtless increase as the birds get older. In size and in quality the half-bred fowls were a very decided improvement on the fowls of the country breed previously kept in the village."

Shortly after the batch of fowls referred to above had been inspected, a successful experiment was made to breed back from the cross to the Dorking. It seems scarcely necessary to observe that by breeding back in this way a pure bred Dorking never can be obtained, but, after a few years' successful breeding, so as to fix the type, the bird produced will so nearly resemble the pure bred Dorking that it will be impossible to distinguish it from one. By selection from a brood of chickens, which showed the characteristic marks of the Dorking, and by carefully raising their progeny, in three years a breed of fowls was established, equal in most respects to the Dorking. They were very handsome birds, and as well suited to the climate of Madras as the indigenous fowls of the district. The color of their plumage was a silver grey, and they were as large as the birds of the Brahma cross, but much more economical for the table, as, from their shorter legs and necks, there was less of the coarser parts, while the breast and most valuable parts were heavily covered with flesh. These fowls produced much larger eggs than country fowls, while they laid quite as many; an average sized egg weighing about 2¼ oz., while an ordinary country egg only weighs about 1 oz.

The effects of the climate, however, told on the original cross-bred fowls imported, and, after seven or eight years, they had so degenerated that it was considered advisable to obtain a fresh supply from Australia: the fowls of the second batch were, however, very inferior to those previously imported. At the same time some Aylesbury ducks were

obtained, and during the same year (1875) a batch of ducks was obtained from Pekin. The latter reached Madras in excellent health; the breed is a very fine one, the birds being more like small geese than ducks. For some time after their arrival the ducks got on very well; they enjoyed perfect health and laid a great number of eggs, many of which were distributed for breeding purposes, but after the first hot season they gradually ceased to lay and then died off. It is possible that younger birds might have been acclimatised.

The following figures show the weights of some eggs of average size:—

—	Weight.	Average weight per egg.
	oz.	oz.
Seven Pekin duck eggs	19·03	2·71
Five Aylesbury duck eggs ...	9·74	1·94
Eight Brahma-Dorking fowls' eggs.	13·73	1·71

Foods and Feeding.—In selecting food for any kind of stock, the species and age of the animal to be fed and the object with which it is being fed must be remembered. Thus the ox can digest more woody fibre in a food than the sheep, whilst the pig seems to be incapable of digesting it at all. Cattle from the size of their stomachs require a bulky food and a considerable amount of water; sheep, on the contrary, do not require so large a volume of food, nor do they require so much water, in proportion to their size. Artificial foods, however, whilst they are most valuable auxiliaries, should not alone constitute the food of sheep. The pig has been proved to make the most use of his food in assimilating it into his structure, and thus fattens easily and quickly, and repays the use of rich foods. If animals are young and in a growing state, they require a larger and more concentrated supply of food for their size than older animals; they require a more highly nitrogenized food for the development of their tissues; and they extract from food a larger amount of its mineral constituents for the formation of their bones, &c. In fattening cattle and sheep, when the wear and tear is reduced to a minimum and the object is to increase the amount of flesh and fat, substances rich in oil, starch, gum, sugar, &c., produce the best results. Milch cattle should always be liberally fed with green fodder, as it causes an increase in the quantity of the milk produced; if the production of butter be the object in view, the use of foods containing a high percentage of oily matters has an effect in increasing the amount; should cheese be the desideratum, the use of leguminous crops, such as gram, owing to the fact that cheese is chiefly composed of casein (the nitrogenous part of milk), will cause an increase of the constituent required.

There is a wide field open for experiments in these subjects, especially in this country; but, unless ample means of all sorts are available, it is not advisable to attempt such investigations. In practice it is often found that the best results are not always obtained from foods considered the best from a chemical point of view; on this

account it is necessary to ascertain the feeding value of a substance, and this varies greatly according to the age, sex, breed, &c., of the animal fed, and with the state of the food—whether it be grown in the cold or in the dry season, whether cut at an early period or when it has attained maturity, whether fed in a green state or after being made into hay, &c.

Pasture.—In Southern India natural pasture is generally very poor, the natural grasses being all, as far as is known, harsh, coarse, and wiry. The pasture lands are most unevenly distributed and no endeavours are ever made to improve them. The growth of forage crops is a branch of husbandry generally ignored, if known, and at any rate unpractised; fodder-raising is however a remunerative branch of agriculture, although the profits from it are not to be immediately counted out in rupees, but are to be found in the larger supplies of organic manure so much required in this famine-stricken land, in the greater number, the better health, the earlier maturity, fuller development, greater power, and stronger constitutions of the live stock.

Artificial, that is, specially cultivated grasses, are never grown, although an unrivalled one exists in Guinea-grass, whilst the Indian cultivator possesses a variety of fodder crops such as would delight the heart of agriculturists in less favored countries. While the agriculturists of this country have so long recognized the advantage of folding sheep at night on arable land, it is strange that the importance of providing green food for consumption on the land has not long ere this been recognized. There is nothing in the practice that is prejudicial to caste or noxious to their feelings.

Fodders.—To test the proportionate feeding value of the fodders mentioned, the experiment recorded below was made with four bullocks, aged from four to six years, in loose boxes. The animals received as much green food as they could consume, the same quantity of corn and cake being given to each; the following were the results:—

Dates of weighing.	Bullock fed on cholum fodder.	Bullock fed on grass.	Bullock fed on Guinea-grass.	Bullock fed on gram fodder.
	LB.	LB.	LB.	LB.
2nd February ...	343	384	287	360
12th do. ...	340	406	304	375
22nd do. ...	335	415	310	375
4th March ...	359	423	315	385
14th do. ...	367	431	329	396
24th do. ...	383	430	331	403
Increase ...	40 lb., or 12 per cent.	46 lb., or 12 per cent.	44 lb., or 15 per cent.	43 lb., or 12 per cent.
	RS.	RS.	RS.	RS.
Comparative cost of fodder ...	25	100	70	30

The result from Guinea-grass is probably larger than will generally be obtained. It has never again given such returns.

An idea is prevalent amongst the ryots of this neighbourhood that cattle will not eat cumboo straw. They certainly do not care for the dry straw of cumboo which has matured its grain; but they are quite as fond of it in the green state as they are of green cholum and other

green fodders. The following experiment was made with green cholum and green cumboo straw :—

Date of weighing.	Bullock fed on	
	Cumboo fodder.	Cholum fodder.
	LB.	LB.
18th July	302	214
28th do.	310	217
Increase	8	3

This experiment was conducted over much too short a period to produce results of any practical value. It however proved, which further experience has confirmed, that not only will cattle eat green cumboo fodder, but that they will thrive upon it.

The following experiment was made to determine the value of gram fodder, in comparison with the grass usually cut for horses, and cholum fodder. Three lots, each lot containing the same number of sheep, were put up to feed and weighed at the end of every ten days. Each lot received the same quantity of corn and cake and as much green food as the animals could consume. The results were :—

Date of weighing.	Average weight of sheep fed on		
	Cholum fodder.	Grass.	Gram fodder.
	LB.	LB.	LB.
2nd February	39·8	40·0	39·8
12th do.	40·6	40·0	40·6
22nd do.	42·0	39·2	42·5
4th March	43·4	41·4	43·4
14th do.	45·2	44·8	45·2
24th do.	46·0	45·8	47·5
Increase	6·2 lb., or 15·5 per cent.	5·8 lb., or 14·5 per cent.	7·7 lb., or 19·3 per cent.

The feeding value of some paddy fodder, grown at a cost of Rs. 2-6-7 per ton, was tested against that of grass, such as is usually provided by grass-cutters, grown on a similar soil as follows :—Of a selected pair of working cattle, one animal was fed on the grass alluded to, and the other on paddy fodder; each sort of forage was given at the rate of 30 lb. per head, and each animal received in addition 4 lb. of oil-cake. They were weighed at the end of every seven days, with the following results :—

Bullock fed	Weighing.										Increase.	
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Total.	Per cent.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
On paddy fodder ...	784	826	836	846	850	860	854	882	876	870	86	10·9
On grass	870	870	840	835	842	868	852	864	861	895	25	2·8

A similar experiment was made with sheep. Four full-grown store sheep were selected and placed in two pens, two in each. Two received daily 15 lb. of paddy fodder, 2 lb. of oil cake, and 2 lb. of tour; the other two received daily 15 lb. of ordinary grass, 2 lb. of oil cake, and 2 lb. of tour. The sheep in both pens were weighed at the end of every seven days. The weighings were as follow :—

Sheep fed	Weighing.										Increase.	
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Total.	Per cent.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.
On paddy fodder ...	172	180	185	186	178	177	179	178	186	188	16	9·3
On grass	154	166	166	166	167	155	160	160	163	167	13	8·4

Other experiments have been made, the results of which agreed generally with those of these experiments. The results appear to be slightly in favor of paddy fodder grown under average circumstances. It is weight for weight as nutritious as the grass, which is almost universally used in this part of India for feeding horses. Paddy fodder can be made into hay, for which purpose it is as well suited as the oat, which is largely so used in some countries for this purpose. It is, perhaps, rather too coarse a food for horses, excepting for those employed at slow work only; but for cattle, either for draught or for dairy purposes, it is well adapted, although as a food for dairy stock it is not as good as cholum fodder as the following proves :—A milch cow, consuming daily 45 lb. of cholum fodder, yielded three measures of milk per diem; when paddy fodder was substituted, though a similar weight was consumed, the yield of milk was reduced to two measures; but when feeding with cholum fodder was again resumed, the daily yield of milk rose to the quantity obtained previous to the change of food.

In May 1883 the following experiment was made to test the value of Reana fodder for a milch cow. The cow Baggium weighed on the 9th of that month 599 lb.; until the 18th she received 75 lb. of Reana fodder daily besides her usual allowance of oil-cake 4 lb., bran 2 lb., dholl husk 2 lb., and a little salt. During this period she

—	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th
Rejected fodder—lb. ...	3	2·50	3	8	7	15	20	23	41	47
Yielded milk—M. M. ...	4·50	4·50	4·50	4·50	4·50	4·50	4·25	4·25	4·25	4·12

On the 19th she weighed 570 lb.; the fodder was changed then to yellow cholum, which was continued till the 29th, when she weighed 589 lb., the artificial food being the same. During this second period she

—	19th	20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th
Rejected fodder—lb.	20	21	22	12	9	11	10·50	14	10·50	11·25	10
Yielded milk—M. M.	4·25	4·50	4·25	4·37	4·37	4·37	4·37	4·37	4·37	4·37	4·37

It will be noticed that the cow lost 29 lb. in weight during the ten days she was fed on Reana fodder; while her yield of milk fell from 4 measures and 4 ollocks a day to 4 measures and 1 ollock. The cow at first, contrary to usual experience, took readily to the Reana fodder and consumed the unusually large quantity of 70 lb. a day; but gradually the fodder became less palatable to her and she rejected more than half of the quantity given on the last two days of the experiment. During the ten days the cow was fed on Reana fodder the milk had a very unpleasant taste, similar to that of the milk of turnip-fed cows, while the quality of the milk was very poor, one measure, on the average, yielding only about 2 oz. of butter. On the eleventh day of the experiment yellow cholum fodder was substituted for Reana fodder; at first the cow consumed only about two-thirds of the allowance of fodder, but the quantity rejected daily became less, until her average consumption of fodder reached 65 lb. In the ten days the cow was fed upon yellow cholum fodder she regained 19 lb. in weight, while her yield of milk increased from 4 measures and 1 ollock to 4 measures and 3 ollocks, and the yield of butter increased from 2 oz. to nearly 4 oz. per measure. The quantity of fodder given to the cow was much larger than the usual allowance; but it was deemed desirable to ascertain the utmost weight of each kind of fodder the cow would consume.

It must be remembered that the nutritious value of any fodder will much depend on the fertility and condition of the soil which produced it. A soil that is naturally rich, or that has been highly manured, will yield a more nutritious fodder than one which is in a more or less impoverished condition.

Chaffing.—The practice of chaffing fodder for cattle has been regularly practised with the best results. It is a most economical arrangement in preventing the waste which always occurs when cattle are fed on long straw. It also enables cattle to be kept in good condition on a smaller allowance of food, as they do not tread into the manure any appreciable amount of chaff; and also as their food is in a finer state of division, they are able to assimilate more of what they eat.

Artificial Foods.—In the following table the analyses of some of the principal pulses of this country are given; they are published on the authority of Professor Church late of the Royal Agricultural College:—

Common name ...	Red gram.	Green gram.	Black gram.	Mochecottay.		Horse-gram.
Botanical name ...	Cajanus Indicus.	Phaseolus Mungo.	Phaseolus Roxburghii.	Lablab vulgaris (Brown).	Lablab vulgaris (White).	Dolichos uniflorus.
Moisture	13·30	10·80	10·10	14·60	14·30	11·00
Oil	2·60	2·65	2·15	2·25	2·20	1·95
Albuminoids	17·09	22·15	22·72	17·09	20·54	20·95
Starch and digestible carbo-hydrates ...	55·73	54·20	55·83	57·51	53·51	56·72
Indigestible fibre ...	7·53	5·80	4·80	5·00	5·80	6·16
Ash	3·75	4·40	4·40	3·55	3·65	3·22
	100·00	100·00	100·00	100·00	100·00	100·00

In the early days of the Farm, besides fodder, horse-gram was the chief food of the cattle. The usual manner of preparing gram by boiling was soon found to be inferior to steeping only; for, quite independently of the fact that boiling renders the albumen of the gram insoluble and therefore less digestible, the cells of the pulse are generally violently ruptured during the boiling process, and a large quantity of soluble nutritious matters is set free; this is lost in the water, and goes to form the soup which is always misappropriated by the coolies. In order to determine the merits of the two methods, the following experiment was made :—

A lot of sixteen draught cattle, similarly worked, was equally divided. One lot was fed daily on 12 lb. of boiled gram and 12 lb. of ground-nut cake, while the other lot received daily 12 lb. of steeped gram and 12 lb. of ground-nut cake. The results were as follow :—

—	The animals fed on	
	Boiled gram.	Steeped gram.
	LB.	LB.
Weighed at the commencement of the experiment ...	6,339	6,310
Do. twenty-seven days afterwards	6,576	6,576
Showing an increase of	237	266
Do. percentage increase of	3·74	4·22

The substitution of steeping for boiling in the preparation of gram as food for horses has been tried in many stables, but the results have not generally been satisfactory; some horses eating steeped gram readily, but others altogether refusing it. As a general rule, recently imported horses eat it better than horses which for years have been fed on boiled gram; and as most of the horses in this part of India are imported from countries in which this pulse is unknown, it would, on their first arrival, be as easy to accustom them to steeped as to boiled gram.

It was discovered at an early date, however, that it was more economical to use ground-nut oil-cake only for cattle food than gram. It is the refuse obtained in the manufacture of oil from the seeds produced in the underground pods of the *Arachis hypogœa*, a plant

already referred to, that is grown very largely in many parts of this presidency as an ordinary field crop. The oil is highly valued in Europe; indeed, it is generally quoted at a price from 10 to 15 per cent. higher than the best linseed oil; it is said to be largely used as a substitute for olive oil, and that it is chiefly used for preserving sardines.

The cake met with here is always made from decorticated seed; the husks are used as fuel, and the ashes therefrom, which amount to ·7 per cent. of the total crop, are generally thrown away; which, as the following extract shows, is a most wasteful practice :—

"The ash of the seed consists of salts wholly soluble in water, they being phosphates of the alkalies, with traces of alkaline chlorides and sulphates. The phosphoric acid is chiefly united with potassa. The ash of the husk differs in containing chiefly common salt, and phosphates of lime and magnesia."

The value of the cake as a feeding stuff has been clearly shown, both by experiment and by scientific reasoning. The following analyses of this oil-cake are interesting :—

Constituents.	Professor Church.		Professor Tuson.		Dr. Vœlcker.	Dr. Anderson.	Average composition of linseed cake.
	Decorticated.	Undecorticated.	Decorticated.	Undecorticated.		Average of two.	
Moisture	9·3	8·1	9·58	9·28	10·80	10·84	12·0
Oil	5·6	8·8	7·40	6·99	8·12	9·80	11·5
Albuminoids	43·4	30·5	42·81	32·81	28·62	30·33	29·7
Carbo-hydrates ...	31·4	27·8	27·63	23·67	18·86	} 45·50	{ 27·8
Indigestible fibre ...	5·2	19·1	7·87	23·80	29·09		12·0
Ash	5·2	5·7	4·71	3·45	* 4·51	† 3·53	‡ 7·0

* Containing sand 1·4. † Containing phosphates 1·15, phosphoric acid ·80.
‡ Containing potash 1·65, phosphate of lime 4·92.

Judging from the analyses given by Professors Church and Tuson of cakes made when the seed is husked and unhusked, those of Dr. Vœlcker and Dr. Anderson refer to samples of undecorticated cake. Comparing the analyses with that of a sample of linseed oil-cake, given by Dr. Vœlcker, the cake will be seen to be not quite so rich in oil and therefore not so well adapted for fattening purposes as that cake; but, as the means of expressing the oil from the seed in this country are very inadequate, in all probability the percentage of oil here is much higher, so that this objection disappears. The high percentage of nitrogenous matters explains why the cake is so useful a food for working cattle.

It may be well to observe that the high percentage of nitrogenous compounds in the cake causes a great increase in the value of the manure made by animals fed on it; for it is calculated by the best authority on the subject, Sir John B. Lawes, of Rothamstead, that the loss of nitrogen in the consumption of cake is about one-tenth of that which it contains, the rest passing off in the manure.

Experiment has proved that working cattle will keep in better condition when fed on ground-nut cake alone, than when fed exclusively on horse-gram as follows :—

—	Cattle fed on	
	Ground-nut cake.	Horse-gram.
	LB.	LB.
First weighing	2,737	3,097
Last weighing twenty-seven days afterwards ...	2,733	3,070

As a food for horses this cake is extremely valuable. It is only necessary to remember that, weight for weight, it is as nutritious as gram, and that in most seasons it can be purchased at a much lower price, to see at once that a great saving would be effected by substituting cake for gram; however, in feeding horses this is not recommended. It is, for such a purpose, a better plan to deduct one-half the usual allowance of gram and to replace this by cake. In this way a saving of 25 per cent. may be effected in the cost of the food of every horse fed on gram, while the condition of the animals would be improved. A Pegu pony, which formerly received daily 2½ measures of gram (uncooked) and was never in good condition, was fed for 18 months on a daily allowance of—

1 measure of gram (uncooked), and 2 pounds of ground-nut cake;

and kept in excellent condition. Under the old method of feeding, his gram at ordinary prices cost monthly Rs. 5-14-2; the food substituted only cost Rs. 3-1-8 per mensem.

Several experiments have been made to test the comparative feeding values of maize and horse-gram. In one case two pairs of working cattle were selected, one animal from each pair being fed similarly in order to ensure that the work performed should be equal. Each pair received 5 lb. of tour and 100 lb. of cholum fodder per diem, in addition, in one case to 6 lb. of gram and in the other to 6 lb. of maize. The results obtained were as follow :—

Weight of pair	Feby. 2nd.	Feby. 12th.	Feby. 22nd.	March 4th.	March 14th.	March 24th.	Increase.
	LB.	LB.	LB.	LB.	LB.	LB.	LB.
Fed on maize ...	1,762	1,765	1,799	1,806	1,806	1,823	127
Fed on gram ...	1,765	1,789	1,767	1,759	1,786	1,768	3

Thus showing that weight for weight maize is superior to gram as a food for working cattle. On another occasion two lots of six wethers each were fed for slaughter; both lots receiving as much gram fodder as the animals would eat, whilst to one 3 lb. bran and 6 lb. maize, and to the other 3 lb. bran and 6 lb. gram were given daily. The results were as follow :—

Date of weighings.	Average weight per head of sheep fed on	
	Gram.	Maize.
	LB.	LB.
2nd February	38·75	37
12th do.	39	37·33
22nd do.	40·83	37·33
4th March	43·83	39·66
14th do.	44·33	42·80
24th do.	45	45
Increase	6·25	8
Increase per cent.	16·13	21·62

As in the case of the cattle experiment, so in this case the maize was novel to the animals, and was not eaten readily during the early part of the experiment. However, as soon as the animals got to like it they made greater progress than those on gram, and the results are very satisfactory. In all probability had the maize and gram been crushed and mixed together before being given to the animals, the result would have been better, for gram and maize serve different purposes in the animal economy; the former being a nitrogenous or flesh producing, the latter a carbonaceous or heat producing food.

Manufacture of Meat.—The following experiment was made to ascertain the relative value of ground-nut cake and maize as food for fattening pigs, and also to determine the cost of producing a pound of pork. Four young pigs, nearly equal in age and in size, were selected; they were placed in loose boxes, two in each; those in pen No. 1 being fed on 4 lb. of ground-nut oil-cake and 4 lb. of tour, and those in No. 2 pen on 4 lb. of maize and 4 lb. of tour daily. Besides these foods a small quantity of green fodder was thrown into each pen two or three times a day, all the pigs getting a similar supply. The pigs were weighed at the end of every week with the following results:—

Pig fed on	Weighings.									Increase.	Pork.	Cost of food.	Cost of pork per lb.
	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.				
	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB.	LB	LB.	RS. A. P.	A. P.
Cake and tour.	236	254	257	257	267	280	314	323	335	99	$59\frac{1}{4}$	4 6 1	1 2
Maize and tour.	255	254	265	270	282	307	320	330	344	89	$53\frac{1}{4}$	7 5 7	2 2

Thus not only is ground-nut cake weight for weight superior to maize for making pork, but also, with the price of the former at 85 lb. per rupee, and the latter at 40 lb. per rupee, 46 per cent. cheaper food.

The next is a small experiment made to determine the cost of producing a pound of beef, and, although partially injured by disease checking the natural increase, the data collected during the thirty-five

days after the disappearance of it are valuable. Two bullocks, which weighed together 692 lb. at the commencement of the experiment, were allowed daily 6 lb. of ground-nut oil-cake and as much fodder as they chose to eat, which amounted to about 50 lb. In thirty-five days they increased 108 lb. in weight; estimating that this increase in their live weight would yield about 42 per cent. beef—the proportion which the cattle of this country are usually found to yield when fairly fattened—the increase will represent about 45 lb. of beef at the following cost for feeding :—

	RS.	A.	P.
Ground-nut oil-cake for 35 days, at 6 lb. per day, valued at 7 rupees per 500 lb. ...	2	15	0
Fodder for 35 days, at 50 lb. per day, valued at 1 rupee for 400 lb.	4	6	0
Attendance, &c.	0	11	0
Total 45 lb. of beef at 2 a. 10 p. per lb. = Rs.	8	0	0

The value of the manure would more than equal the cost of the straw required for bedding, the value of the accommodation, &c.

In another experiment, after sixteen weeks' feeding on horse-gram a bullock increased in weight 125 lb., which would yield about 52 lb. of beef, the cost being as follows :—

	RS.	A.	P.
Gram, 3 lb. per day, for 112 days, valued at 36 lb. per rupee	9	5	4
Fodder, 30 lb. per day, for 112 days ...	8	6	4
Attendance, &c.	2	0	0
Total 52 lb. of beef at 6 a. 1 p. per lb. = Rs.	19	11	8

An experiment was made in feeding a "lot" of bullocks, which were purchased at Rs. 15 each. The charges made for food include the cost of chaffing, crushing, and preparing it. The charge under the column headed "Attendance, &c.," is composed of a monthly charge of 6 annas per head for attendance, &c., and 2 annas per head to pay interest, &c., on the cost of the cattle box: one man, at 5 rupees per month, can easily attend to fifteen feeding cattle: the loose boxes cost each about 12 rupees. With one exception the cattle were all slaughtered and sold on the Farm. The average price obtained for the beef was 4 annas a pound. One-fifth of the cost of cake, corn, and bran, &c., is credited for manure. The following are the results :—

When feeding commenced.		When killed.				Food consumed.						Expenditure.			Receipts.			
				Produced.														
Date.	Live weight.	Date.	Live weight.	Pounds of beef.	Per cent. of beef.	Maize.	Tour.	Bran.	Ground-nut cake.	Cholum straw.	Paddy staw.	Cost of food.	Cost of attendance, &c.	Total cost.	Sum realized for beef.	Value of manure.	Total.	Profit.
	LB.		LB.	LB.		LB.	LB.	LB.	LB.	LB.	LB.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
26th Feb....	476	18th June...	523	219½	42·6	183	...	...	178	1,108	850	17 13 8	2 0 0	34 13 8	48 6 9	1 7 4	49 14 1	15 0 5
Do. ...	484	21st May...	516	214½	41·47	120	...	...	120	903	545	12 1 8	1 8 0	28 9 8	48 3 0	0 15 6	49 2 6	20 8 10
Do. ...	457	7th do. ...	...	221	...	...	...	101	96	800	416	9 8 7	1 4 0	25 12 7	48 15 6	0 11 9	49 11 3	23 14 8
Do. ...	410	1st Jan. ...	...	264	...	...	90	498	716	3,388	1,224	46 5 7	5 0 0	66 5 7	63 11 6	5 4 4	68 15 10	2 10 3
Do. ...	516	4th June...	570	244¼	42·98	157	16	136	...	1,042	776	15 6 0	1 12 0	32 2 0	51 3 0	1 2 0	52 5 0	20 3 0
Do. ...	376	6th July...	Sold alive		...	216	80	141	...	1,298	1,000	21 1 8	2 4 0	38 5 8	45 0 0	1 11 9	46 11 9	8 6 1

Many experiments have been made in sheep-fattening, amongst others the following :—

Number of sheep.	Weight at commencement. Total.	Weight at commencement. Average.	Average duration of experiment.	Live weight on day of slaughter.	Produced. Net weight of mutton.	Produced. Per cent. of mutton.	Purchased food consumed. Gram.	Purchased food consumed. Bran.	Purchased food consumed. Cotton seed.	Purchased food consumed. Oil-cake.	Expenditure. Cost of sheep.	Expenditure. Cost of corn and cake.	Expenditure. Cost of other food, attendance, &c.	Expenditure. Total cost.	Receipts. Value of manure.	Receipts. Price realized.	Receipts. Total.	Profit.
	LB.	LB.	DAYS.	LB.	LB.		LB.	LB.	LB.	LB.	RS. A.	RS. A.	RS. A.	RS. A.	RS. A.	RS. A.	RS. A.	RS. A.
8	512	64	116	600	211¼	45	444	222	338	...	32 0	21 12	5 0	58 12	5 7	69 13	75 4	16 8
12	600	50	139	732	312	43	810	435	...	548	36 0	37 4	8 8	81 12	9 5	81 14	91 3	9 7
12	528	44	199	708	310	44	1,070	615	780	...	30 0	44 4	9 8	83 12	11 1	79 9	90 10	6 14
11	514	46	203	754	337	45	1,244	612	...	816	27 8	55 9	9 0	92 1	13 14	84 0	97 14	5 13
12	556	46	171	698	345	49	1,032	516	688	...	30 0	42 0	9 0	81 0	10 8	86 4	96 12	15 12
12	560	47	171	792	356	45	1,032	516	...	688	30 0	46 9	9 0	85 9	11 10	89 0	100 10	15 1

The following figures show how results may vary with the kind of animal selected for fattening. Two bullocks very similar in general appearance were chosen; both animals were similarly fed, the daily food of each consisting of 3 lb. of horse-gram and as much fodder as it could consume, about 30 lb.; the animals were weighed at the end of each week as the experiment progressed, with the following results:—

Weight.	Bullock No. 1.	Bullock No. 2.
	LB.	LB.
First week	378	390
Second do.	388	408
Third do.	396	402
Fourth do.	416	390
Fifth do.	396	378
Sixth do.	406	395
Seventh do.	420	398
Eighth do.	413	395
Ninth do.	419	390
Tenth do.	427	399
Eleventh do.	429	395
Twelfth do.	456	396
Thirteenth do.	470	397
Total increase ...	92	7
Increase per cent ...	24	2

This experiment is instructive in showing how differently two animals will progress and lay on flesh, even when fed with exactly the same food and under exactly similar conditions. This fact is well known to feeders in England, who will frequently readily give from ten shillings to a pound a head more for cattle from one part of the country than for those from another part, though the cattle for which the higher price is given may in no respect look better than those which are less appreciated.

In conclusion it may be well to observe that, in the present state of the social customs of the country, it will scarcely be necessary to prosecute fattening experiments to any extent, it having been proved that both beef, mutton, and pork can be raised at remunerative rates. The value of ground-nut cake is incontestable, and the comparative value for feeding of a grass very easily grown—Guinea grass as well as that of several other fodders—has been clearly demonstrated. Steeped gram has been shown to be productive of better results than boiled, whilst maize is superior as a food to either. There, however, yet remain many questions to be solved before feeding in India can be reduced to the science it is in England.

APPENDICES.

APPENDIX

Statement showing Weekly Rainfall

Weeks	1870-71.		1871-72.		1872-73.		1873-74.		1874-75.		1875-76.		1876-77.		1877-78.	
	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.
1	...	...	...	...	...	...	2·20	2	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	·18	1	...	...	...	...	...	...	...	...
3	...	...	...	...	...	...	...	...	...	...	...	...	...	.	...	...
4	...	...	...	...	...	...	...	...	...	...	...	...	...	.	...	...
5	...	...	...	...	7·55	3	...		5·80	1	...	...	·81	1	...	...
6	...	...	...	...	...	...	...	...	·71	1	...	...	·48	2	...	...
7	...	...	·33	1	...	...	...	...	...	...	...	...	...	...	...	..
8	...	...	...	...	...	...	...	...	·28	1	...	...	...	...	22·23	4
9	...	...	...	..	...	...	...	...	...	...	·01	1	·82	2	·10	1
10	...	...	·79	1	..	...	·48	2	4·93	4	...	..	...	...	...	...
11	6·70	4	·10	1	1·25	1	·66	2	·42	1	·26	2	1·65	2	1·62	3
12	·28	1	·45	1	·16	1	·17	1	...	...	·05	1	...	...	·30	3
13	1·34	3	·10	1	...	...	·37	1	1·31	2	...	...	·42	2	·33	1
14	...	.	·89	1	...	...	·56	3	·84	1	·25	1	...	..	...	...
15	1·06	2	2·75	1	·58	2	·04	1	1·58	3	·35	1	·72	4	...	...
16	1·83	3	2·35	3	·29	2	·15	2	2·26	3	...	...	1·22	3	·04	1
17	3·43	4	·90	2	...	...	·75	3	·78	1	·06	1	·93	3	1·17	4
18	2·16	2	...	...	2·76	3	·53	2	...	...	2·95	2	·80	1	1·07	5
19	3·82	4	·35	1	3·86	4	...	...	·99	3	1·16	3	·22	1	·73	3
20	1·50	2	·95	1	·30	2	...	...	1·10	1	3·98	4	·40	2	·52	3
21	...	...	...	...	·82	1	2·46	4	·25	1	·55	1	·36	2	·71	2
22	2·20	2	·49	1	1·25	2	1·12	2	2·55	1	·50	2	2·71	3	·37	2
23	·89	1	·33	1	·12	1	·23	1	2·41	5	·23	1	1·81	2	3·67	4
24	3·30	3	...	...	2·53	2	...	..	2·82	2	1·03	2	·01	1	·25	1
25	2·71	3	4·80	2	1·71	2	2·50	3	·50	1	2·76	1	...	...	...	
26	...	...	3·10	2	...	...	3·56	2	2·31	3	·19	1	·28	1	1·87	3
27	3·55	1	·59	1	·79	2	4·04	5	1·15	1	1·61	1	1·34	1	·88	3
28	·35	1	...	...	9·94	4	4·22	6	...	...	·91	3	1·01	1	...	...
29	5·30	4	4·39	4	6·48	3	1·55	4	3·23	2	1·72	4	·54	1	·35	2
30	7·43	6	1·23	2	1·20	2	1·41	2	17·53	7	·98	3	...	...	·53	4
31	...	...	5·53	3	...	...	1·08	1	...	...	·08	1	·45	2	8·95	6
32	·56	2	13·83	5	2·41	3	...	...	1·40	2	1·92	2	·12	1	5·90	4
33	3·21	6	1·64	3	2·44	2	2·24	5	·10	1	8·47	5	2·07	3	9·37	4
34	1·73	4	4·62	2	15·69	7	2·80	3	·25	1	5·13	4	...	...	1·13	2
35	...	...	1·02	1	10·59	4	10·02	7	7·50	3	...	...	1·55	2	1·10	2
36	1·00	2	...	...	3·58	2	4·25	3	...	...	2·34	4	...	...	1·30	2
37	...	...	·19	1	1·56	1	...	...	5·01	4	·38	2	...	...	·84	2
38	...	...	...	...	2·08	2	·50	1	...	...	·27	1	...	...	...	.
39	...	...	...	...	...	...	...	...	·10	1	...	...	·14	3	...	...
40	·20	1	...	..	...	...	...	...	...	...	...	...	...	...	...	...
41	...	...	...	...	...	...	...	...	...	...	...	.	...	...	..	...
42	·15	1	...	...	...	...	...	...	...	..	...	...	·02	1	·22	1
43	1·05	1	...	...	...	...	...	.	·10	1	...	...	...	...	...	...
44	...	...	...	...	...	...	...	.	...	...	...	...	...	...	...	...
45	...	...	·75	1	6·23	4	...	...	..	...	...	...	...	...	...	...
46	...	...	...	..	...	...	...	...	...	...	...	..	...	...	...	...
47	...	...	...	...	...	..	...	..	...	...	...	...	...	...	...	...
48	·68	1	...	..	...	..	...	...	·77	1	...	...	...	...	...	...
49	·70	2	·06	1	...	...	...	...	...	...	..	...	...	.	...	..
50	...	...	...	..	...	..	...	..	...	...	...	.	...	...	...	...
51	...	...	...	..	...	..	...	..	...	..	...	..	...	...	...	...
52	..	..	...	...	...	...	...	...	...	...	...	..	...	...	...	...
Total.	57·07	66	52·53	44	86·17	62	48·07	69	68·98	59	38·14	54	20·88	47	65·55	72

A.

at Saidápet for 14 years and average.

Weeks	1878-79.		1879-80.		1880-81.		1881-82.		1882-83.		1883-84.		Averages.	
	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.
1	...	...	...	...	...	...	...	...	...	...	...	...	·15	·14
2	...	...	...	...	·02	1	...	...	...	...	...	...	·01	·14
3	·67	2	...	...	...	...	...	...	...	...	...	...	·04	·14
4	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	·10	1	...	...	...	...	...	...	...	...	...	...	1·01	·42
6	...	...	...	...	...	...	...	...	...	...	...	...	·08	·21
7	2·10	2	...	...	...	...	...	...	...	...	...	...	·17	·21
8	0·70	1	3·99	3	...	...	·14	1	...	...	...	...	1·95	·71
9	1·00	1	...	...	...	...	·10	1	...	...	...	...	·14	·42
10	...	...	1·08	5	...	...	·36	2	·09	1	·76	3	·60	1·28
11	...	...	·05	1	·89	3	·05	1	...	...	...	...	·97	1·50
12	...	...	...	...	·52	3	·47	1	·01	1	·56	3	·21	1·14
13	·10	1	·68	5	·17	2	·02	1	·85	1	1·38	5	·50	1·78
14	2·05	3	·07	2	1·40	3	...	...	·89	5	3·82	4	·76	1·64
15	...	...	...	...	·48	4	·29	3	1·15	4	2·85	5	·84	2·14
16	·75	1	·53	3	1·46	1	...	...	·15	1	3·23	3	1·01	1·85
17	·52	3	·12	2	·70	2	·75	1	·46	3	·38	3	·77	2·28
18	1·14	3	·84	5	·28	3	2·15	1	·43	4	·36	4	1·10	2·42
19	·53	1	·02	1	·63	2	3·51	4	1·00	4	·18	2	1·21	2·64
20	3·98	4	2·32	3	1·87	5	·30	1	·39	2	·13	1	1·26	2·21
21	·47	2	·74	4	...	...	1·10	3	1·88	3	2·10	4	·81	1·92
22	...	...	4·00	6	·49	5	·58	2	2·15	3	·20	3	1·32	2·42
23	4·23	5	·70	2	4·45	2	1·36	1	2·88	4	·02	1	1·66	2·21
24	1·04	5	·50	1	6·00	6	·98	4	·06	1	...	...	1 32	2·00
25	·15	1	...	...	...	...	4·50	4	·58	1	0·1	1	1·44	1·35
26	·60	3	...	...	·40	1	·90	1	...	...	·32	1	·96	1·28
27	1·57	3	7·52	4	·62	3	2·81	4	2·00	3	4·64	4	2·36	2·57
28	4·67	2	2·63	3	·34	2	...	...	1·74	3	2·23	5	2·00	2·14
29	·78	4	1·40	2	2·03	5	...	...	1·41	3	8·22	6	2·67	3·14
30	...	...	4·23	5	7·02	7	·05	1	2·92	2	1·93	3	3·31	3·14
31	...	...	3·78	6	3·61	4	·65	3	·27	1	10·97	6	2·58	2·35
32	·97	1	2·66	3	5·80	4	3·56	6	1·94	2	2·22	6	3·08	2·92
33	...	...	4·28	2	2·13	7	8·95	4	7·30	4	...	...	3·73	3·28
34	·01	1	3·80	2	3·11	5	3·65	2	9·77	5	5·40	3	4·07	2·92
35	·21	3	·70	1	8·04	5	·05	1	9·49	6	...	...	3·59	2·50
36	1·63	3	1·26	2	1·27	4	...	...	...	...	...	...	1·18	1·57
37	·02	1	...	...	...	...	1·73	3	...	...	10·39	5	1·43	1·35
38	·07	1	·45	3	1·70	2	·95	1	...	...	·47	1	·46	·85
39	·33	2	3·80	2	1·00	3	·80	1	...	...	·97	1	·51	·51
40	...	...	...	...	...	...	3·52	5	...	...	·68	1	·31	·50
41	·05	1	...	...	·75	1	...	...	...	...	·05	1	·06	·21
42	·35	1	...	...	...	...	...	...	...	...	...	...	·05	·35
43	·27	1	·45	1	...	...	...	...	...	...	1·63	1	·25	·35
44	·05	1	1·85	2	...	...	...	...	...	...	...	...	·13	·21
45	...	...	...	...	...	...	...	...	...	...	...	...	·49	·35
46	...	...	...	...	...	...	...	...	...	...	...	...	...	...
47	...	...	2·50	1	...	...	...	...	...	...	...	...	·17	·07
48	...	...	...	...	...	...	...	...	...	...	...	...	·10	·14
49	...	...	...	...	...	...	...	...	...	...	...	...	·05	·21
50	...	...	...	...	...	...	...	...	...	...	...	...	...	...
51	2·05	3	...	...	...	...	...	...	...	...	...	...	·14	·21
52	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total.	33·16	67	56·95	82	57·18	95	44·28	63	49·81	67	66·10	86	53·01	66·29

APPENDIX

Statement showing Fortnightly Rainfall

Fortnights.	1870-71.		1871-72.		1872-73.		1873-74.		1874-75.		1875-76.		1876-77.	
	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.
1	...	...	...	...	...	...	2·38	3	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	...	...	...	...	7·55	3	...	...	6·51	2	...	...	1·29	3
4	...	...	·33	1	...	...	...	...	·28	1	...	...	...	...
5	...	...	·79	1	...	...	·48	2	4·93	4	·01	1	·82	2
6	6·98	5	·55	2	1·41	2	·83	3	·42	1	·31	3	1·65	2
7	1·34	3	·99	2	...	...	·93	4	2·15	3	·25	1	·42	2
8	2·89	5	5·10	4	·87	4	·19	3	3·84	6	·35	1	1·94	7
9	5·59	6	·90	2	2·76	3	1·28	5	·78	1	3·01	3	1·73	4
10	5·32	6	1·30	2	4·16	6	...	...	2·09	4	5·14	7	·62	3
11	2·20	2	·49	1	2·07	3	3·58	6	2·80	2	1·05	3	3·07	5
12	4·19	4	·33	1	2·65	3	·23	1	5·23	7	1·26	3	1·82	3
13	2·71	3	7·90	4	1·71	2	6·06	5	2·81	4	2·95	2	·28	1
14	3·90	2	·59	1	10·73	6	8·26	11	1·15	1	2·52	4	2·35	2
15	12·73	10	5·62	6	7·68	5	2·96	6	20·76	9	2·70	7	·54	1
16	·50	2	19·36	8	2·41	3	1·08	1	1·40	2	2·00	3	·57	3
17	4·94	10	6·26	5	18·13	9	5·04	8	·35	2	13·60	9	2·07	3
18	1·00	2	1·02	1	14·17	6	14·27	10	7·50	3	2·34	4	1·55	2
19	...	...	·19	1	3·64	3	·50	1	5·01	4	·65	3	...	...
20	·20	1	...	...	...	...	...	...	·10	1	...	...	·14	3
21	·15	1	...	...	...	...	...	...	...	...	...	...	·02	1
22	1·05	1	...	...	...	...	...	...	·10	1	...	...	...	...
23	...	...	·75	1	6·23	4	...	...	...	...	...	...	...	...
24	·68	1	...	...	...	...	...	...	·77	1	...	...	...	...
25	·70	2	·06	1	...	...	...	...	...	...	...	...	...	...
26	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total ...	57·07	66	52·53	44	86·17	62	48·07	69	68·98	59	38·14	54	20·88	47

B.

at Saidápet for 14 *years and average.*

1877-78.		1878-79.		1879-80.		1880-81.		1881-82.		1882-83.		1883-84.		Averages.	
Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.	Rainfall.	Wet days.
...	...	...	...	...	...	·02	1	...	...	...	...	...	...	·16	·28
...	...	·67	2	...	...	...	...	...	...	...	...	...	...	·04	·14
...	...	·10	1	...	...	...	...	...	...	...	...	...	...	1·09	·63
22·33	5	2·80	3	3·99	3	...	...	·14	1	...	...	...	...	2·12	·92
...	...	1·00	1	1·08	5	...	...	·46	3	·09	1	·76	3	·74	1·70
1·92	6	...	...	·05	1	1·41	6	·52	2	·01	1	·56	3	1·18	2·64
·33	1	2·15	4	·75	7	1·57	5	·02	1	1·74	6	5·20	9	1·26	3·42
·04	1	·75	1	·53	3	1·94	5	·29	3	1·30	5	6·08	8	1·85	3·99
2·24	9	1·66	6	·96	7	·98	5	2·90	2	·89	7	·74	7	1·87	4·70
1·25	6	4·51	5	2·34	4	2·50	7	3·81	5	1·39	6	·31	3	2·47	4·85
1·08	4	·47	2	4·74	10	·49	5	1·68	5	4·04	7	2·30	7	2·13	4·34
3·92	5	5·27	10	1·20	3	10·45	8	2·34	5	3·51	5	·02	1	2·98	4·21
1·87	3	·75	4	...	...	·40	1	5·40	5	...	...	·33	2	2·40	2·63
·88	3	6·24	5	10·15	7	·96	5	2·81	4	3·75	7	6·87	9	4·36	4·71
·88	6	·78	4	5·63	7	9·05	12	·05	1	4·32	4	10·15	9	5·98	6·28
14·85	10	·97	1	6·44	9	9·41	8	4·21	9	2·66	4	13·19	12	5·66	5·27
10·50	6	·01	1	8·08	4	5·24	12	12·60	6	16·67	9	5·40	3	7·80	6·20
2·40	4	1·84	6	1·96	3	9·31	9	·05	1	9·44	5	...	...	4·77	4·07
·84	2	·09	2	·45	3	1·70	2	2·68	4	...	...	10·86	6	1·89	2·20
...	...	·33	2	3·80	2	1·00	3	4·32	6	...	...	1·65	2	·82	1·01
·22	1	·40	2	...	...	·75	1	...	...	...	...	·05	1	·11	·56
...	...	·32	2	2·30	3	...	...	...	...	...	...	1·63	1	·38	·56
...	...	...	...	...	...	...	...	...	...	...	...	...	...	·49	·35
...	...	...	...	2·50	1	...	...	...	...	...	...	...	...	·27	·21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	·05	·21
...	...	2·05	3	...	...	...	...	...	...	...	...	...	...	·14	·21
65·55	72	33·16	67	56·95	82	57·18	95	44·28	63	49·81	67	66·10	86	53·01	66·29

APPENDIX C.

Detailed Statement of Rainfall at Saidápet from the official year 1870-71 *to the year ending* 31*st March* 1884 *and average.*

Months.	1870-71.						1871-72.						1872-73.					
	Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.	
	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.
April	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	·33	1	...	...	·33	1	·25	1	7·30	2	7·55	3
June	2·92	6	5·40	2	8·32	8	1·44	4	...	...	1·44	4	·16	1	1·25	1	1·41	2
July	3·48	8	5·00	3	8·48	11	2·69	5	4·20	2	6·89	7	1·27	5	1·68	1	2·95	6
August	1·72	5	5·80	3	7·52	8	1·79	3	...	...	1·79	3	3·19	7	3·27	2	6·46	9
September	3·00	5	3·90	2	6·90	7	·33	1	7·90	4	8·23	5	1·94	5	3·02	2	4·96	7
October	2·73	8	13·90	4	16·63	12	1·69	5	4·52	2	6·21	7	2·36	7	15·90	3	18·26	10
November	3·94	11	1·50	1	5·44	12	3·09	7	23·55	7	26·64	14	2·58	7	28·55	9	31·13	16
December	1·20	3	...	...	1·20	3	·19	1	...	...	·19	1	1·32	2	5·90	3	7·22	5
January	·15	1	1·05	1	1·20	2	...	...	...	...	...	...	...	...	...	...	...	...
February	·68	1	...	...	·68	1	·75	1	...	...	·75	1	·78	2	5·45	2	6·23	4
March	·70	2	...	...	·70	2	·06	1	...	...	·06	1	...	...	...	...	...	...
Total ...	20·52	50	36·55	16	57·07	66	12·36	29	40·17	15	52·53	44	13·85	37	72·32	25	86·17	62

APPENDIX C—(*Continued*).

Detailed Statement of Rainfall at Saidápet from the official year 1870-71 *to the year ending* 31*st March* 1884 *and average*—(Contd.).

Months.	1873-74.						1874-75.						1875-76.					
	Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.	
	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.
April	·71	2	1·67	1	2·38	3	...	...	...	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	·99	2	5·80	1	6·79	3	...	...	...	...	...	...
June	1·68	6	...	...	1·68	6	1·52	4	5·14	3	6·66	7	·32	4	...	...	·32	4
July	1·50	9	...	...	1·50	9	3·68	7	1·78	1	5·46	8	·66	3	...	...	·66	3
August	1·74	6	1·42	1	3·16	7	1·24	4	1·10	1	2·34	5	4·33	10	4·81	2	9·14	12
September	2·65	5	4·59	2	7·24	7	4·47	9	6·12	3	10·59	12	1·45	4	2·76	1	4·21	5
October	4·25	11	8·05	7	12·30	18	1·35	3	20·56	7	21·91	10	2·51	10	2·79	2	5·30	12
November	7·31	13	1·60	1	8·91	14	·75	3	8·50	4	9·25	7	1·05	6	14·47	5	15·52	11
December	·58	2	10·32	3	10·90	5	1·31	3	3·80	2	5·11	5	1·33	6	1·66	1	2·99	7
January	...	...	...	...	...	...	·10	1	...	...	·10	1	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	·77	1	...	...	·77	1	...	...	...	...	...	...
Total ...	20·42	54	27·65	15	48·07	69	16·18	37	52·80	22	68·98	59	11·65	43	26·49	11	38·14	54

APPENDIX C—(*Continued*).

Detailed Statement of Rainfall at Saidápet from the official year 1870-71 *to the year ending* 31*st March* 1884 *and average*—(Contd.).

Months.	1876-77.						1877-78.						1878-79.					
	Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.	
	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.
April	·81	1	...	...	·81	1	...	...	...	...	...	...	·67	2	...	...	·67	2
May	·55	3	...	...	·55	3	·75	2	21·58	3	22·33	5	1·25	3	2·65	2	3·90	5
June	1·57	4	1·25	1	2·82	5	1·18	6	1·07	1	2·25	7	·10	1	...	...	·10	1
July	3·67	11	...	...	3·67	11	1·40	7	...	...	1·40	7	2·27	6	1·05	1	3·32	7
August	1·79	7	1·90	1	3·69	8	3·15	12	...	...	3·15	12	3·10	9	3·02	1	6·12	10
September	·86	3	1·24	1	2·10	4	2·56	8	3·36	2	5·92	10	2·64	12	3·38	2	6·02	14
October	·99	3	2·35	2	3·34	5	2·39	10	7·48	2	9·87	12	2·35	7	4·67	2	7·02	9
November	1·69	4	2·05	2	3·74	6	2·91	7	14·29	6	17·20	13	1·19	5	...	...	1·19	5
December	·14	3	...	...	·14	3	·93	3	2·28	2	3·21	5	·50	6	1·55	1	2·05	7
January	·02	1	...	...	·02	1	·22	1	...	...	·22	1	·72	4	...	...	·72	4
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	·80	2	1·25	1	2·05	3
Total ...	12·09	40	8·79	7	20·88	47	15·49	56	50·06	16	65·55	72	15·59	57	17·57	10	33·16	67

APPENDIX C—(*Continued*).

Detailed Statement of Rainfall at Saidápet from the official year 1870-71 *to the year ending* 31*st March* 1884 *and average*—(Contd.).

Months.	1879-80.						1880-81.						1881-82.					
	Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.	
	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.
April	...	...	...	...	...	...	·02	1	...	...	·02	1	...	...	...	...	...	...
May	·09	2	3·90	1	3·99	3	...	...	...	...	...	...	·14	1	...	...	·14	1
June	1·81	11	...	...	1·81	11	1·58	8	...	...	1·58	8	1·00	6	...	...	1·00	6
July	1·33	10	...	...	1·33	10	1·63	9	2·56	2	4·19	11	1·04	4	2·15	1	3·19	5
August	3·17	12	4·07	3	7·24	15	1·88	13	1·24	1	3·12	14	2·34	8	2·95	1	5·29	9
September	1·27	4	...	...	1·27	4	2·34	7	8·65	3	10·99	10	2·94	10	5·01	2	7·95	12
October	2·29	9	16·84	8	19·13	17	3·85	14	6·89	3	10·74	17	·10	2	2·75	2	2·85	4
November	2·09	7	9·78	4	11·87	11	6·24	15	13·38	8	19·62	23	3·96	12	12·90	4	16·86	16
December	1·81	6	3·70	1	5·51	7	3·97	9	2·20	1	6·17	10	3·48	5	2·95	2	6·43	7
January	·75	2	1·55	1	2·30	3	·75	1	...	...	·75	1	·57	3	...	...	·57	3
February	...	...	2·50	1	2·50	1	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total ...	14·61	63	42·34	19	56·95	82	22·26	77	34·92	18	57·18	95	15·57	51	28·71	12	44·28	63

APPENDIX C—(*Continued*).

Detailed Statement of Rainfall at Saidápet from the official year 1870-71 *to the year ending* 31*st March* 1884 *and average*—(Contd.).

Months.	1882-83.						1883-84.						Average, 1871-84.					
	Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.		Falls under 1 inch.		Falls over 1 inch.		Total.	
	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Number.	Amount.	Wet days.	Amount.	Wet days.	Amount.	Wet days.
April	...	...	...	...	...	...	...	...	...	...	...	...	·16	·43	·12	·07	·28	·50
May	...	...	...	...	...	...	...	...	...	...	...	...	·31	1·07	2·94	·64	3·25	1·71
June	·95	3	...	...	·95	3	2·70	11	...	...	2·70	11	1·35	5·36	1·01	·57	2·36	5·93
July	1·80	14	1·00	1	2·80	15	3·86	13	6·47	3	10·33	16	2·16	7·93	1·85	1·07	4·01	9·00
August	2·81	11	2·82	2	5·63	13	2·89	12	...	...	2·89	12	2·51	8·50	2·31	1·29	4·82	9·79
September ...	1·23	6	2·45	1	3·68	7	0·38	4	2·10	1	2·48	5	2·00	5·93	3·89	1·86	5·89	7·79
October	1·87	7	6·47	5	8·34	12	3·76	12	16·03	8	19·79	20	2·32	7·71	9·22	4·07	11·54	11·78
November ...	4·01	8	24·46	8	28·47	16	3·04	8	10·68	4	13·72	12	3·13	8·07	11·84	4·50	14·97	12·57
December ...	·03	1	...	...	·03	1	1·69	3	10·14	4	11·83	7	1·32	3·78	3·18	1·43	4·50	5·21
January	...	...	...	...	...	...	·73	2	1·63	1	2·36	3	·29	1·14	·30	·22	·59	1·36
February	...	...	...	...	...	...	...	...	...	...	...	...	·16	·29	·57	·21	·73	·50
March	...	...	...	...	...	...	...	...	...	...	...	...	·16	·43	·09	·07	·25	·50
Total ...	12·70	50	37·20	17	49·90	67	19·05	65	47·05	21	66·10	86	15·87	50·64	37·32	16·00	53·19	66·64

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